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ABSTRACT

Telemedicine is defined as the use of two-way or interactive television to conduct transactions in the field of health care. A history of its development to provide two-way communication between central facilities and remote locations is given, along with descriptions of pioneer systems. Technical, psychological and cultural aspects of the method are explored, along with the physician's reaction to it. Twenty present and pending projects in its use are described; capability and acceptance in general diagnosis, cardiac problems, dermatology, radiology, psychiatry, mental retardation, and speech therapy are assessed. Issues and questions are identified. An appendix gives information on transmission, equipment, services, configurations and schedules for 13 projects in operation as of Jan. 31, 1974. (SK)

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AN INTRODUCTION TO TELEMEDICINE

Interactive Television for Delivery of Health Services

BEN PARK

Supported by Grants from
The Rockefeller Foundation

JUNE 1974

THE ALTERNATE MEDIA CENTER
At the School of the Arts
New York University

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AN INTRODUCTION TO TELEMEDICINE

Interactive Television for Delivery of Health Services

Ben Park

Supported by the Rockefeller Foundation

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PREFACE

The major issues besetting the American people in the field of health are those of cost, quality, and accessibility of services. I have long been convinced that two-way television between urban medical centers and those in sub-urban or remote rural areas could do much to contain costs while enhancing the quality and accessibility of needed health services. But the subject is an extremely complex one and there is need for much more fundamental research - both sociologic and biologic, whether in economics, psychology and behavior, or physiology. Ben Park's review of telemedicine is a valuable summary of past and present experience and should do much to stimulate the development of the field.

John H. Knowles, M.D.
President, the Rockefeller Foundation

AUTHOR'S FOREWORD

This report is addressed primarily to those who are interested in planning and implementing the use of interactive television as an alternative means of delivery of services in the health field. Herein "services" will mean consultations and therapy in patient care, professional education and training, conferencing, and administrative functions.

My investigation of interactive television began in January, 1972 but was sporadic until April, 1973 when grants from the Rockefeller Foundation enabled me to give telemedicine my full attention for a year. Visits to the operational telemedicine projects and to other locations in advanced stages of telemedicine implementation, participation in conferences and seminars, as well as extensive meetings and correspondence with a growing group of people who are becoming knowledgeable about various aspects of telemedicine have constituted the bulk of this investigative effort. Because telemedicine is a recent phenomenon, the body of literature it has generated is relatively small. Studies and writing in related fields such as telecommunications for delivery of social services and education, sociology of interaction, and communications and systems theory have been helpful in adding to my understanding of the complex issues that telemedicine involves.

The history and current operations of telemedicine, as well as abstracts of studies of assessment capability and acceptance of telemedicine are presented herein as straight reportage. Chapters on communication aspects and research needs attempt to synthesize what I believe to be the most informed, insightful, provocative , or innovative thinking that has been brought to bear on these subjects by observers and students of telemedicine from diverse disciplines.

To the extent that the reader is ignorant of current experience in telemedicine he or she will find new information here, but the report will be of greatest value to the reader who is encouraged to approach this report as a participant in the process of thinking about a new and challenging idea.

The people who have given time and thought to aiding my understanding of their work in or study of telemedicine number several score. I wish to thank a few whose contributions have been exceptionally valuable to me.

Maxine Rockoff has been a central figure in funding eight new telemedicine projects and in initiating a series of conferences and workshops bringing together many people involved in the practice and study of this innovative concept. In addition to making it possible for me to become acquainted with many knowledgeable people I might otherwise have missed, she has given me many thoughtful hours in discussions and correspondence.

Kenneth Bird introduced me, as he has so many others, to the telemedicine concept. He has given generously of his time and has provided access to published and unpublished materials generated by the Massachusetts General Hospital's telemedicine projects.

Erving Goffman and his student, John Carey, have guided and encouraged my deeper study and thinking about human communication in the interactive television medium.

Many telemedicine practitioners have graciously tolerated my requests to inspect their operations, submit to long interviews, provide written materials, engage in correspondence, and correct those sections of the manuscript which refer to their experience. Their names are prominent in this report.

For the insights they have given me in personal discourse I thank Allen Shinn, Thomas Willemain, Roman Mrozinski, Eliot Freidson, Gary Schober, Cecil Wittson, and my colleagues at the Alternate Media Center, Red Burns, Eileen Connell, Robert Mariano, Jacqueline Park, and George Stoney.

For their published contributions to new ways of thinking about communication I am especially indebted to Gregory Bateson, Kenneth Boulding, Edmund Carpenter, Buckminster Fuller, Erving Goffman, Edward Hall, Harold Innis, Ithiel de Sola Pool, Lee Thayer, and Norbert Wiener.

This report was made possible by the Rockefeller Foundation. John Knowles took personal interest in the work and I hope he will feel it has fulfilled some of his expectations.

Ben Park
June, 1974

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CHAPTER I

TELEMEDICINE: A SUMMARY DEFINITION AND OVERVIEW

Telemedicine is defined in this report as the use of two-way or interactive television to conduct transactions in the field of health care. Interactive television enables human communication employing the visual and auditory senses. Telemedicine also permits transmission of the outputs of a wide array of medical instrumentation. Participants see and are seen, hear and are heard, in real time. They can question, respond and demonstrate. In many telemedicine locations participants have remote control of the cameras which transmit visual information to them. (A series of photographs from telemedicine locations, with explanatory text, is found on page 11.)

Television technology has been used by the health care establishment since the earliest days of television. Until the advent of interactive television, medical use was confined to one-way transmission, which is what we see at home. Telemedicine is fundamentally and significantly different. Its two-way transmission is fully interactive, whereas ordinary television is active from the source and passive at the receiver's end.* The differences can best be understood in terms of feedback. Because its information flow is bi-directional, telemedicine provides the means for such feedback.

Telemedicine has experienced very rapid development since 1972. Prior to then, it was being explored in three pioneer locations from 1960 onward. Although it did not receive widespread serious attention for its first twelve years, the concerns that are motivating considerable current interest in telemedicine were present from the beginning:

- Maldistribution of facilities and professional expertise, as medical specialization and technology came to represent increasingly interdependent and expensive resources which gravitated for economic reasons to highly-centralized locations.
- The tendency on the part of post-World War II medical school graduates to specialize rather than to pursue general practice, and so to move closer to the centralized facilities they need in order to keep abreast of modern practice.

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* One-way television is, in itself, a one-way information flow. On occasion it is provided with the means for limited feedback. During a "live" telecast, viewers may have a voice link by means of which they may ask or answer questions and make comments. They can show neither illustrative material nor non-verbal reactions. It is possible to introduce an element of interaction by means of devices which display multiple choices and are capable of limited branching. This development of "television as teaching machine" is promising and may have wide application. However, it is not to be confused with fully-interactive television. Viewing of videotapes of themselves by psychiatric patients, would-be suicides, and alcoholics is another employment of one-way television that is finding increasing utility. Interaction between patient and therapist can be modified considerably by the self-confrontation technique. If this interaction between patient and therapist is conducted via interactive television then it becomes a telemedicine application.

- The resultant difficulty of access to adequate health care in rural areas, inner-city slums, and many rapidly-growing suburbs as the older generation of physicians was not replaced and other physicians did not choose to practice in those areas. Community health facilities deteriorated because of the lack of professional staffs.

- Difficulty of providing up-to-date continuing education, in-service training, or access to modern facilities for the diminishing numbers of isolated health professionals or to those who might want to practice in relative isolation.

- Rising expectations by all segments of the population, including the traditionally disadvantaged, for better health care and facilities, as the realization grew that good care is not a privilege but a right.

- Escalating costs of medical services.

Interactive television is seen as an answer to some or all of these problems in many situations because of its ability to compress time and distance between providers and consumers of caring and educational services. The substance of the vast majority of these services is communication, and interactive television facilitates instantaneous communication over distances that are now as great as 250 miles and may in the future be far greater. Interactive television can bring the patient and the physician, the professional and the consultant, the teacher and the learner into visual and auditory contact. It enables the scarce resources represented by all the specialties to be in contact with widely-spaced distant locations at the times when their expertise is needed for education, consultation, or therapy. In projects linking multiple locations, the consultant or teacher may interact with patients and professionals in one location after another or more than one at the same time without moving from his or her own central base. Consumers, patients, subordinate professionals and students receive services in community hospitals, at urban outreach or rural clinics, or at distant buildings within a scattered institutional complex. In many instances interaction via telemedicine means the difference between receiving service and not receiving it at all. In most instances it means the difference between ready access and difficult access. In all instances it represents more convenient access than travelling to the source.

At the time of this writing telemedicine is being utilized in thirteen projects which serve nearly forty separate institutional sites in twenty-one cities and towns.

These projects represent a wide range of applications. There are large projects, such as the New Hampshire/Vermont "Interact" network which links the medical schools of the University of Vermont (Burlington, Vt.) and Dartmouth College (Hanover, N. H.), community hospitals in Claremont, N. H., Bellows Falls, Vt., and Barre, Vt., a community college in Claremont, and a state prison in Windsor, N. H., for continuing and in-service education, consultation, diagnosis, therapy, and conferencing. There are small projects, such as the single link which provides medical consultation from a small group of physicians at the community hospital in Blue Hill, Maine to a nurse practitioner 25 miles distant in Stonington, Maine, at the seaward end of Deer Isle in Penobscot Bay. There are projects which serve urban areas, while others serve rural areas. Some projects combine multiple caring, educational, and administrative applications, yet some have narrower applications. Telemedicine projects are based on private non-profit institutions, public institutions, and private group practices.

Projects becoming operational in 1974 will further diversify the application of telemedicine. Indigenous Alaskan Eskimos and Aleuts will be served by a system using satellite transmission; nurses seeing inmates of Miami and Dade County, Florida jails will receive teleconsultation from physicians at the University of Miami Medical Center; nurse practitioners at remote primary-care clinics in the sprawling city of Jacksonville, Florida will receive consultation for their patients from physicians at University Hospital; the half-million people who live in Puerto Rico's southern region will be provided a number of services, as will professionals in smaller centers, by a system whose first two-way link will unite a community hospital at Guayama with the Regional Hospital at Ponce; a system based on the University of Ohio Medical Center in Columbus will deliver diagnostic, therapeutic, and professional education services to the Appalachian region of southeast Ohio around Athens and new telemedicine systems will link Veterans Administration hospitals in a number of states and regions.

Descriptions of existing and projected telemedicine projects will be found in Chapter IV and Appendix A.

Is telemedicine a stop-gap solution or are we seeing the beginnings of a permanent application of interactive television to delivery of health care? Will the current trend toward wider development of telemedicine facilities institutionalize TV technology while inhibiting other solutions, such as training enough professionals or building enough facilities to provide universal face-to-face care? Is the current proliferation of telemedicine a remedy for dissatisfaction about delivery of health services or is it merely a symptom of this dissatisfaction?

These are not the questions raised by the person who has most to gain or lose, the patient. Instead, the patient asks: Why can some Americans get the best medical care in the world and I get no care at all? Do I have to be sick in order to get to see a doctor? Why did it cost so much to put mother in the hospital just to die?

"The current initiatives for the development of telemedicine take place at a very opportune time. There is widespread public feeling that something is wrong with the delivery of health services in the United States. The politicians are responding with proposals for major legislation involving the establishment of a national health insurance program, the promotion of Health Maintenance Organizations (HMO) and the creation of Professional Service Review Organizations (PSRO). While politicians are busy promoting their ideas and organized medicine continues to lobby for legislation most favorable to it, the consumers are often left facing the technical, medical complexities with bewilderment and frustration. Indeed, it can be surmised that the average patient goes to the average physician without knowing exactly when it is proper to seek care, pays a certain fee without knowing exactly what constitutes a fair charge, and receives medical treatment without being in a position to judge its quality. Hence, general public frustration with the system should make the consumers more open to new methods for solutions to their problems."*

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* Bashshur, Rashid L., "Telemedicine and Medical Care" in Bashshur, Rashid L., Armstrong, Patricia A., Youssef, Zakhour I., eds., Telemedicine, Explorations in the Use of Telecommunications in Health Care, published by Charles Thomas, Springfield, Ill., 1974 (forthcoming)

Professionals who are active in telemedicine are generally enthusiastic about it. They contend that interactive teleivision enables interaction and feedback for the satisfactory accomplishment of most of the functions associated with primary care,* education, and many types of therapy. In some instances, telemedicine allows communication that is said to be superior to face-to-face interaction.

General feasibility of the medium has been established in studies which have evaluated telemedicine's assessment and disposition capability in general diagnosis, auscultation, dermatology, radiology, psychiatry, mental retardation and speech therapy, as well as in evaluations and reports from active telemedicine projects which cover a wider spectrum of educational, consultative, therapeutic, and administrative functions. Palpation cannot be done currently but some experienced users state that description of topography, texture, tone, etc., by a trained assistant under the scrutiny of the remote physician provides adequate information in a majority of situations encountered.

Most telemedicine projects currently employ black and white television, rather than color. Eventually most systems will have color capability, but many telemedicine principals currently reason that:

- Color today costs at least twice as much to install and maintain, that the benefits obtained from it are marginal;
- Color television of the United States NTSC standard is not stable, requires constant adjustment, and is therefore rarely "true," and
- Dermatologic diagnosis, for example, can be performed satisfactorily with black and white, when the trained assistant with the patient describes color.

Patient acceptance of telemedicine has been reported as favorable in one formal study from Massachusetts General Hospital and all active telemedicine projects report that patients' attitudes are favorable toward seeing professionals via two-way television.

One study of professional acceptance has been made. Nurses in the N.H./Vt. "Interact" system received continuing education via interactive television and indicated both positive and negative attitudes about the experience. It was positive in that the subjects felt their education had been advanced, yet negative in that they felt the face-to-face experience would have been superior.

No formal study of physicians' attitudes toward telemedicine has been made. From current reports and extensive interviews on the subject, it would appear that:

- Physicians who use telemedicine with some degree of regularity as providers (consultants, educators, therapists) tend to be favorable to the medium.
- Physicians in positions of asking for consultation are favorable to telemedicine when they feel no personal threat to their status or integrity, but are reserved

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* An early study at Massachusetts General Hospital suggested that two-way television "in conjunction with a skilled professional nurse clinician or practitioner can be used to manage successfully over 90% of the general medical problems seen at a primary care ambulatory medical facility." (See"Diagnosis, General" in Chapter V.)

- Physicians who have had no experience with telemedicine generally take positions about it that range from dubious to denigrating. An exception to this generalization is found among those physicians who perceive that telemedicine can respond to unmet needs for which they see no available alternative solution that is as satisfactory.

Questions, Issues and Problems

Telemedicine practitioners and students of the medium are aware that between telemedicine's present and future potential lies an awesome number of questions, issues and problems.

- The capacity of the technology already incorporated in telemedicine projects (to say nothing of more sophisticated technology which is already available or theoretically possible) outstrips understanding of its optimal use by telemedicine participants.

  People using telemedicine and those using interactive television in education, business, government and law enforcement are penalized because they are pioneers. New communication techniques require a substantial period of trial and error and increasing proliferation before utilization of them approaches "ordinary" behavior. Even the telephone still is used with varying degrees of efficiency and effectiveness.

- The problem of optimal use of interactive television technology is exacerbated by impatience based on users' perception of technology as a "plug-in" facility which should allow them to do whatever they wish without any special training or understanding.

  Unfortunately, experienced telemedicine practitioners and funding sources have come belatedly to the realization that reliable evaluation of the medium is impossible until utilization of it approaches reasonable optimization. When transactions are overlong; when users do not know how to achieve reliable visualizations, clarity of sounds, or ready comparability among various visual and/or sound elements; when conferences are inhibited because some people are out of microphone range, out of the light, out of camera range; when interactions are interrupted or crippled by what is perceived, for sociocultural or psychological reasons, as confusing, threatening, or insulting behavior by a participant; when any of these things, and more, occur, a need is seen for study of behavior at the human/technological interface as well as for concurrent learning and understanding by users.

- Development of technology uniquely adapted to television interaction will progress only as users can be made to specify their precise needs. However, users must become more sophisticated about the nature of interaction and their relationship to technology in order to be able to generate reliable information about the nuances of perception to which the technology must respond.

- Relationships among professional users of interactive television apparently are altered when roles take on meanings and are endowed with responsibilities different from what is normal in face-to-face settings. Role meanings and responsibilities are further varied in relation to functions. For example, the nurse who needs information normally obtained directly by the physician may have to ask questions which force the physician to impart information not ordinarily part of the nurse's training. When the nurse asks, "What are you looking for?", "What is it you want me to show you?", it is frequently necessary for the consultant to become a teacher. Information requested by one party may also require increased skill in manipulation of equipment by the other party.

A patient often comes to a primary care location and is first seen by a nurse practitioner, nurse clinician, or physician's assistant. The non-physician professional is constrained by protocols or standing orders to the performance of certain procedures (e.g., routine general physical examination, history-taking and continuation of management). Any problem, complaint or finding not covered by protocols or standing orders requires referral which is made via telemedicine unless the condition requires immediate hospitalization.

Study of role relationships among professionals using telemedicine should attempt to establish a satisfactory re-definition of role functions. Explicit definition of role functions must assure patients of a level of medical care consistent with established norms. In other words increased ease of access to primary care cannot permit unsupervised care by a substitute physician. Integration of physician - non-physician role functions represents increasing responsibility by non-physicians and must be subject to control and review.

At what point does dependence on the nurse or referring physician become intolerable to the consultant? How willing is the physician to educate the nurse? How willing is the nurse to accept greater responsibility, not only for performance of some physician tasks but for the responsibility that comes from increased knowledge? How willing is the referring physician to have his or her knowledge appear inferior to the consultant's in the presence of the patient? Will the greater contact with professional colleagues at all levels and the growing participation by consumers in the newer systems of health care tend to diminish the control of their clients by physicians? Will resistance by physicians to this state of affairs prove an effective barrier to proliferation of telemedicine facilities? Under what conditions will physicians feel that telemedicine is worthwhile?

It would seem that physicians who have practiced in groups or in teaching hospitals will find adaptation to telemedicine easier than will solo practitioners, because the former are more accustomed to sharing responsibilities for patient care, to free exchange among colleagues and to well-meant challenges about practice.

What organizational changes in the overall system of health care are likely to take place as a result of further decentralization of health care delivery? It is unlikely that telemedicine's major outreach will be restricted to providing backup consultation to primary care clinics staffed by non-physicians. If health professionals can be supported by telemedicine consultation and continuing education, may there not be a reversal of the trend of physicians to gravitate toward centralized facilities and for more medical graduates to practice in rural, suburban, and inner-city areas? If such technologically-facilitated re-distribution of medical manpower were to become a reality, then it is possible to predict that these communities will be in positions to demand concurrent development or renovation of secondary-care community hospitals and/or primary-care clinics which do not exist today or have fallen to sub-standard classification. The ideal for each community would be a system consisting of manpower, caring facilities and telecommunication whose size and configuration would be determined by and suited to the needs of the population in its service area.

Redistribution of caring manpower and facilities could spell concomitant shifts in the economics, administration, policy-making functions, governmental relationships, and patient relationships of the health establishment.

- The technology involved in health service redistribution probably should be integrated with similar technological developments in education, government, industry, social service, law enforcement and the court systems, to avoid duplication of hardware that can be shared without loss of facilitation. It is likely that microwave technology, although now widely used for point-to-point distribution between individual facilities, will give way to coaxial cable distribution within relatively small areas and that "airwaves" such as microwaves, including those transmitted via satellites as well as land towers, will be used to deliver signals only between facilities and systems at greater distances. Implementation of microwave requires finding frequencies not already occupied, and obtaining licenses for frequencies from the Federal Communications Commission.* In most large urban areas finding suitable available frequencies is becoming difficult, so finding multiple frequencies to link multiple locations may be next to impossible.

  Cable television can link large numbers of locations, if institutions can lease a sufficient number of dedicated, secure channels from a local commercial cable (CATV) system which has bi-directional capability. However, the number of channels available for any one special purpose may represent only a fraction of the CATV's total capacity. Thus, should towns and municipalities be wired with separate two-way cable systems dedicated exclusively to service objectives?

  Here we are confronted by questions of national priorities and how much such development will be supported by public and private resources.

- Cost, quality, and access are the evaluation standards by which innovations in delivery of health care must finally be judged. Are costs reasonable for services provided? Is care as well as education of acceptable quality? Is the system readily accessible to both providers and consumers? Despite enthusiasm for the medium, no telemedicine practitioner claims unequivocal proof of its cost effectiveness, its ready accessibility, or the adequacy of quality of its service. However, telemedicine ideally does provide:

  Consultation in less time, a factor which increases in significance proportionate to the time of physical travel and seriousness of the problem involved.

  Consultation or education which otherwise would not be sought, due to difficulty of travel or cultural barriers.** This factor also increases in significance in relation to need for the service involved.

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* Unless microwave facilities are leased from organizations like the Bell System.

** Note that difficulty of travel is not related only to distance and transportation, but to physical or mental disability. Cultural barriers comprise socioeconomic, linguistic, ethnic and class factors. Patients will go to East Harlem's Wagner Clinic who will not go to the Mount Sinai Medical Center a mile away.

Facilitation of supervision at a distance. This has a direct bearing on feasibility of providing care through secondary hospitals and outreach clinics, earlier discharge of patients from the hospital, and efficiency in the use of supervisors' time.

Conferencing and continuing education among participants at two or more locations, simultaneously.

Implications for potential saving of travel time and costs are obvious in most of the above. What dollar value should be assigned to raising the educational level of professionals throughout the system? What is the dollar value of earlier diagnosis and care to those otherwise unable or reluctant to obtain them? What is the societal value in improving the health of significant numbers of people whom the health care establishment otherwise does not reach or reaches only with considerable difficulty? What is the value of enabling patients to shorten hospital stays, with adequate supervision at home by television? What is the societal value in limiting energy consumption through reduced travel?

To date, such benefits may be subject to theoretical cost analysis, but precise evaluation of cost/benefit or cost-effectiveness of most telemedicine facilities, as well as the assessment of quality and access, founders on the issue of suboptimal utilization.

Suboptimal utilization comprises two separate problems: awkwardness of communication, and underutilization. The former has been discussed above.

In telemedicine systems, what are chiefly underutilized are the capacities of the facilities. Increased utilization of facilities depends on: Larger numbers of consumer locations to which links are provided; this requires additional transmission links and assumes that adequate staff would be available at these locations; and/or use of the facility for purposes other than delivery of health and medical services. It can be estimated that utilization of facilities providing consultation services from a large hospital tele-center to primary care clinics will approach saturation only when those clinics are sufficient in number or size to demand teleconsultations at the rate of one every ten to twelve minutes. *

The irony is that current telemedicine projects do not have sufficient funds to buy additional equipment, and in many cases would face difficulties in securing transmission paths if they could afford them.

In the meantime, some telemedicine systems are moving positively in other directions toward improving utilization. The reasoning goes something like this: "Although our limited facilities can reach only a fraction of the people our professional resources are capable of serving in consultation and therapy or for conference, there are many

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* Based on the Cambridge project experience, which showed that an average of eight minutes was spent, per tele-consult. The additional two to four minutes is an estimated average time required to get physicians "on line," assuming that, in every case, a patient is awaiting consultation and that, as implied, there are a number of remote stations from which consults are being requested. The average 2-4 minutes includes situations where one physician is dealing, seriatim, with patients who are at a number of locations as well as where different physicians are requested and must be called to the tele-center at the hospital.

other societal needs to which interactive television can respond. If our systems can respond to these other needs, we will spread system costs over a wider base. "Students attend bi-directional classes in health and mental hygiene conducted by professionals; classes are held for public school teachers interested in learning disability and adolescent counselling; a study of hearing impairment and another of learning disabilities in children have been conducted; courses in pharmacy have been given to nurse practitioners and other students; adult education courses, parole board meetings, and various types of counselling have all been conducted via telemedicine facilities. Many telemedicine systems are exploring similar means for greater utilization, including nights and weekends, if functions do not require excessive additional staffs.

There remains the question of quality, which becomes intertwined with cost and access in the utilization matrix. Access to a wide array of professional skills is limited to the small number of terminal outreach locations connected, usually, to a single location back at the central institutional complex. It is sometimes not feasible to summon the appropriate physician to the central institution's single tele-center; thus quality of care may suffer. Proliferation of locations and channels would obviate the problem. Furthermore, as long as human interaction in the medium is poorly understood and as long as technology is ill-adapted to professional needs and professionals to the technology, one must assume that quality potentials have not been realized.

No sizable body of patients has been studied over a sufficient period of time to determine long-term outcomes or other effects of having received care via telemedicine. Such a controlled study currently is difficult to perform, since prior base data on most of the universes of patients seen via telemedicine are almost non-existent and there has not been a large group of patients who receive all their medical attention via telemedicine. *

Most telemedicine practitioners believe that the caring services which have been provided to date are satisfactory, given the self-imposed requirement that physicians must feel secure with the information the medium provides. If they are uneasy with the transaction, they make alternative arrangements for the patient to be seen or cared for. For all the caution exercised, however, the vast majority of patient transactions initiated via telemedicine have been satisfactorily concluded via telemedicine.

The questions that are raised about quality of services delivered via telemedicine include: How much diagnostic information is lost in the inability of the physician to assess the patient's reaction to the physician's touch? Will professionals become overdependent on telemedicine to the extent that massive technical failure will result in breakdown of the caring system and interruption of critical management? Is it necessary to develop means of isolating patients from the more extensive dialogue between consultant and nurse that is often required for use of the medium, lest patients become unnecessarily frightened or are motivated to improper self-treatment? How is quality to be defined, by whom, and how is it to be controlled? Must quality of care to a remote

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* New telemedicine systems, such as those based on Jacksonville's University Hospital and the Regional Hospital in Ponce, Puerto Rico, plan to deliver consultation to primary care centers serving large numbers of patients. Data from such systems as these may, in the future, provide material for study of long-term outcomes and effects.

area meet the standards of the community from which it is provided? What place does "something is better than nothing" assume when "something" may not represent the very best but "nothing" is equivalent to neglect?

Many questions about telemedicine's facilitation of quality of service are remarkably similar to questions about the quality of service provided by the health and medical establishment, generally. As such, these questions may underline the need for answers about the health professions in general. Perhaps they are raised about telemedicine because it is perceived as an isolated and unproven entity, as well as a potential means of extending the service capacity of the health establishment.

A General Comment on Telemedicine Research

It may be that research on telemedicine should be undertaken as a massive, unified, large-scale project pursued over a period of years. Certainly such an approach could go far to insure against duplication of effort and to promote planned integration among the various utilizations. This approach, assuming it covered the widest variety of applications of technology, populations served, and professional and institutional configurations, would have the advantage of producing coordinated and non-conflicting data of a very high degree of reliability. Its chief disadvantage is that such a project, costing hundreds of millions of dollars may not become attractive enough to finance until much of what it aims at learning has been rendered obsolete by an unplanned and far more costly jumble of duplicated services.

In the meantime, we are seeing implementation of discrete projects backed by an obvious willingness on the part of different federal agencies and foundations to explore what interactive telecommunication technology can provide for a number of health services objectives. The advantages in this multi-faceted and relatively disorganized approach are that the medium is being explored, albeit diffusely, and each sponsoring organization persists in learning about what the medium can do. Although there has been some evidence of initial duplication of effort and re-invention of wheels, recent federal initiatives in the health field have been pursued with a clear understanding of the need for comprehensive information exchange among contracting organizations and sponsors. Current research has been shared. Research problems have been openly discussed among telemedicine project principals, as well as a growing number of individuals and organizations with interests in utilization of the interactive television medium for a variety of societal purposes.

If an ideal massive research effort is not mounted, encouragement should be given to implementing research projects that can provide useful information about both the utilization of interactive television for societal needs and the effects of IATV on social structures. It is equally important that research continue to be shared in the manner

Illustrations of Telemedicine Facilities

Fig. 1 shows a typical consultation in the Massachusetts General Hospital (Boston) - Bedford (Massachusetts) Veterans Administration Hospital telemedicine setting. Physician and patient in foreground are in the teleconsultation studio at Bedford; the consultant seen on the television screen is 23 air miles distant in the tele-center at Massachusetts General. The physicians can listen simultaneously to the output of an electronic stethoscope. The camera which can be seen below the television screen is transmitting a picture of patient and stethoscope placement to the distant physician. The transmission is carried via microwave signals in both directions.*

Fig. 2 shows on the telvision screen to the left, one of the pictures that may be seen by the consultant at Massachusetts General Hospital. The picture on the screen is from the large camera at the left. The picture (not seen here) from the camera beneath the monitor is a lateral view of the patient's chest. The microphone over the near physician's head is trained in the direction of patient and physician so that they can speak in normal tones and be heard easily by the consultant. The nurse holds an additional microphone because she is out of range of the overhead microphone and may be called on to give salient details of the patient's history, condition, or management. Patient, physician, and nurse hear the consultant's voice from the upright rectangular speaker in the right background. The camera mounted beneath the television monitor is under the control of the distant consultant. Electronic signals activated by a joy stick at his hand cause the camera to tilt up or down and pan to left or right. With a set of pushbuttons he can cause the 10:1 zoom lens to move in or out for close or wide views, focus the lens, or vary the size of the lens aperture (f-stops). In addition, he can transmit a "cursor" - a moveable electronic pointer - which appears as a small white rectangle on the picture from the patient's location (television screen at the left); this enables the distant physician to call attention to areas of interest he wishes to discuss.

Fig. 3 shows the control panel used by consultants at Massachusetts General Hospital in transactions with the Bedford Veterans Administration Hospital. The joy sticks next to the physician's thumbs permit panning and tilting remote cameras in the directions shown by the arrows. The lower rows of buttons control iris (open or close), zoom (in or out), and focus (near or far). Buttons in the top rows permit the consultant to select and activate equipment.

Fig. 4 shows how the distant consultant can view X-ray films mounted on standard view-boxes. His control of the camera lens permits him to view large or small areas of the film, which are seen on his television screen at magnifications up to 10:1.** By controlling the camera aperture, he can increase or decrease contrast.

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* Other projects transmit two-way television signals via coaxial cable, laser beams, infra-red beams. Systems using video telephones transmit via ordinary telephone wires.

** 10:1 is an approximate figure, based on using a camera lens capable of resolving an image 2 inches by 1.5 inches displayed on a standard 23-inch television screen (diagonal measurement).

Figs. 5 and 6 illustrate a different type of telemedicine setup, in the Lakeview Clinics project which interconnects group-practice facilities at Jonathan and Waconia, Minnesota and Ridgeview Hospital in Waconia. Camera, monitors, microphones, speaker, electronic stethoscope and videocassette recorder all are housed in readily moveable television carts, of which there are two at the hospital and one at each clinic. The system's transmission is via channels of a 13-mile television cable between the two towns. The physician is using the cart at the clinic in Waconia to view an ECG paper tracing at the Jonathan Clinic.

Fig. 7 indicates the flexibility of telemedicine in the Lakeview Clinics project. All patient rooms, ICU-CCU, emergency rooms and conference rooms of Ridgeview Hospital are wired so that a hospital attendant can roll a television cart* to a location and plug in its power and cable terminals. Physicians at either clinic location may see and converse with their hospital patients and hospital personnel at any hour. This application has proved useful in constant monitoring of severely ill patients and patients in delivery rooms, in consultations, and for emergency supervision.

Fig. 8 from the Logan Airport Medical Station in Boston illustrates transmission of photomicroscopy. A beam-splitter permits both the laboratory professional and television camera (the large, gray rectangle) to view the slide simultaneously. The picture being transmitted from the camera to a consultant at Massachusetts General Hospital is seen on the small monitor screen. Nurse and consultant talk to each other by means of microphones and speakers (not shown).

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* "Television carts" are used in some other systems. This one happens to use them most flexibly, because it was possible to wire all rooms in the hospital, as well as a number of locations at each clinic. It is recommended that any new health care location be provided with ample conduits to facilitate ubiquitous telecommunication, via coaxial cables, fiberoptic strands, or other conductors. Such conduits must have soft bends, not right-angle turns, and should be capable of carrying two 1/4" coaxial cables. Cables need not be drawn immediately, but emplacement of conduits assures that the option of future cabling will not be foreclosed.

FIGURE 1

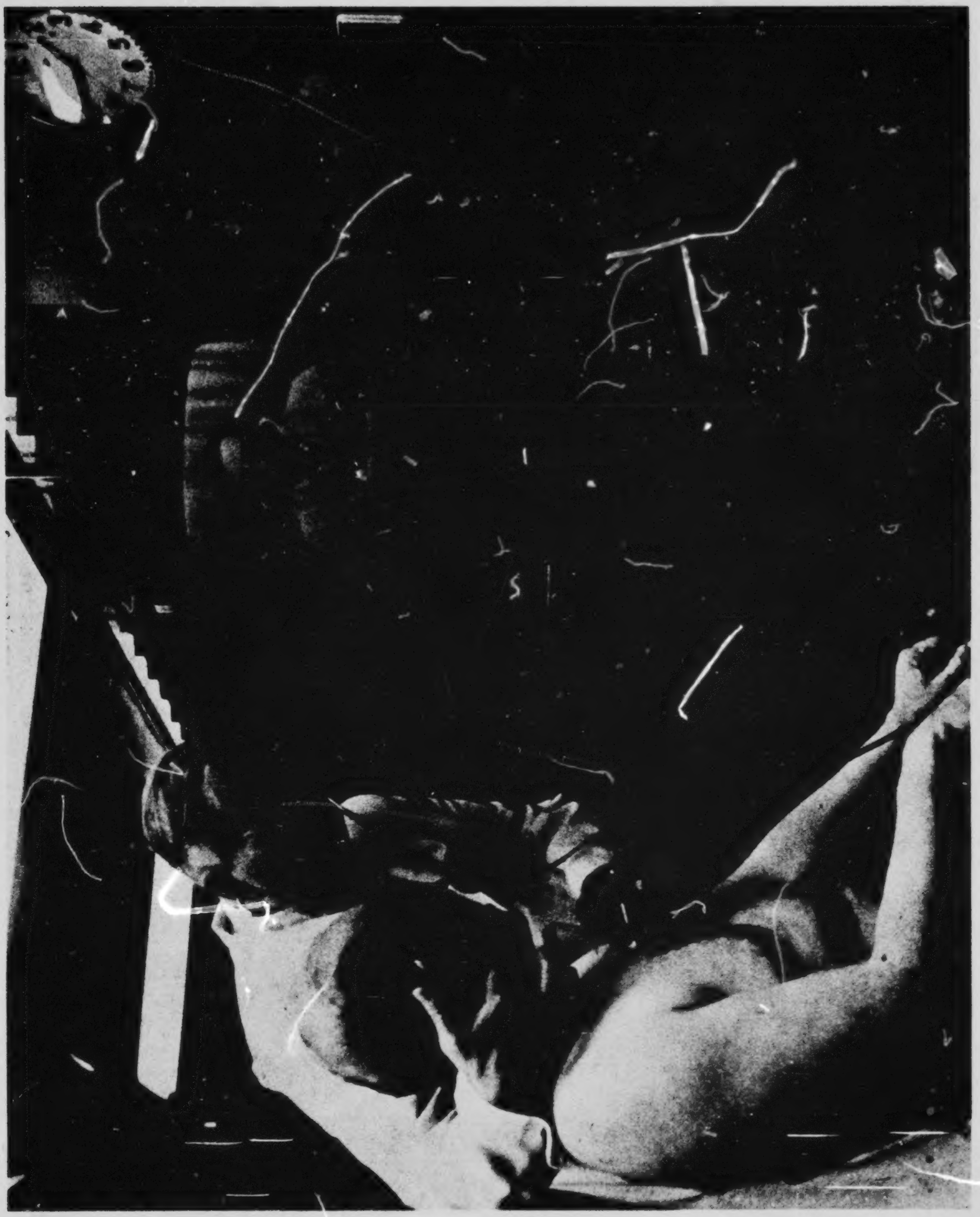


FIGURE 2

FIGURE 3

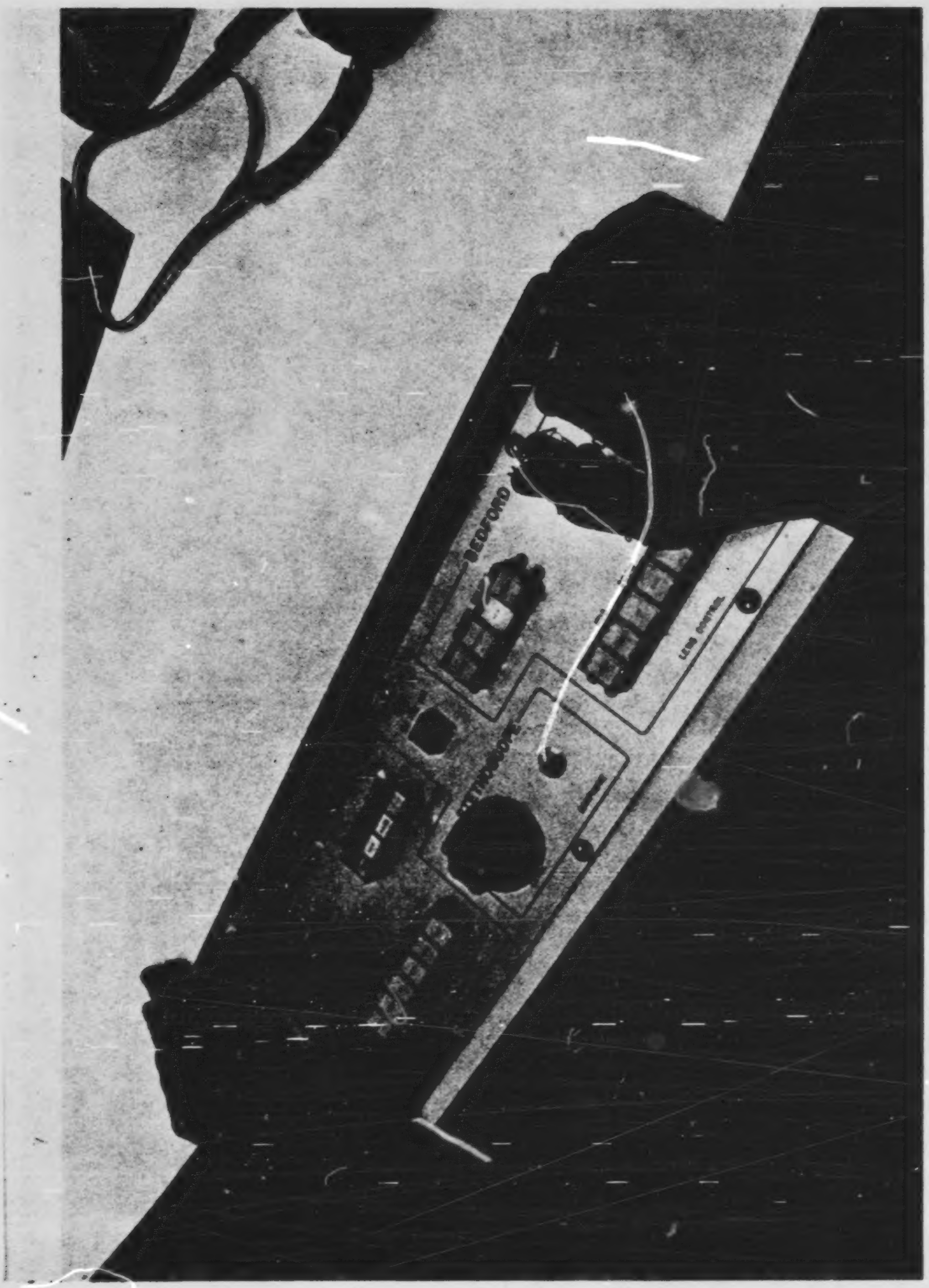


FIGURE 4

FIGURE 5

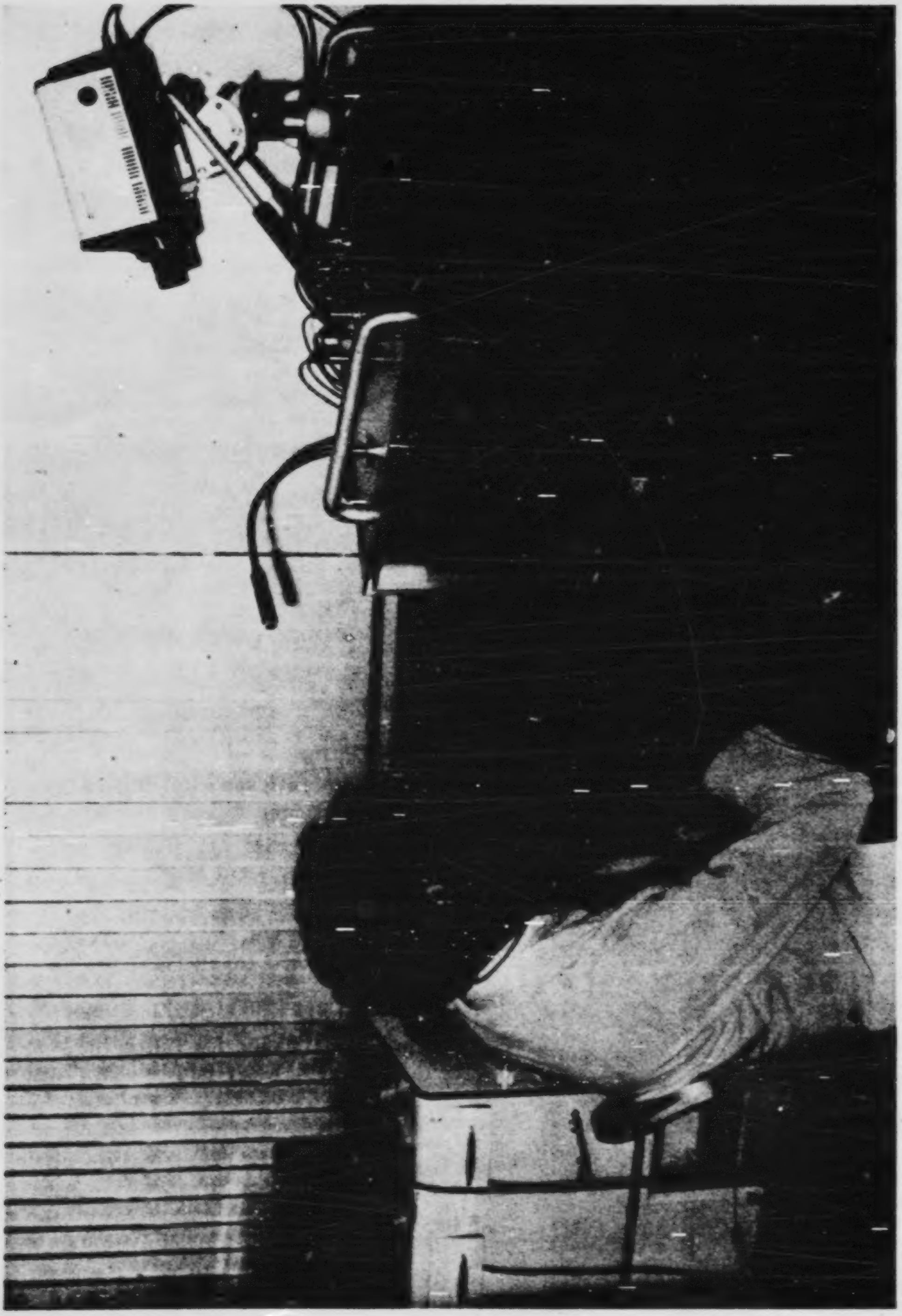


FIGURE 6

FIGURE 7

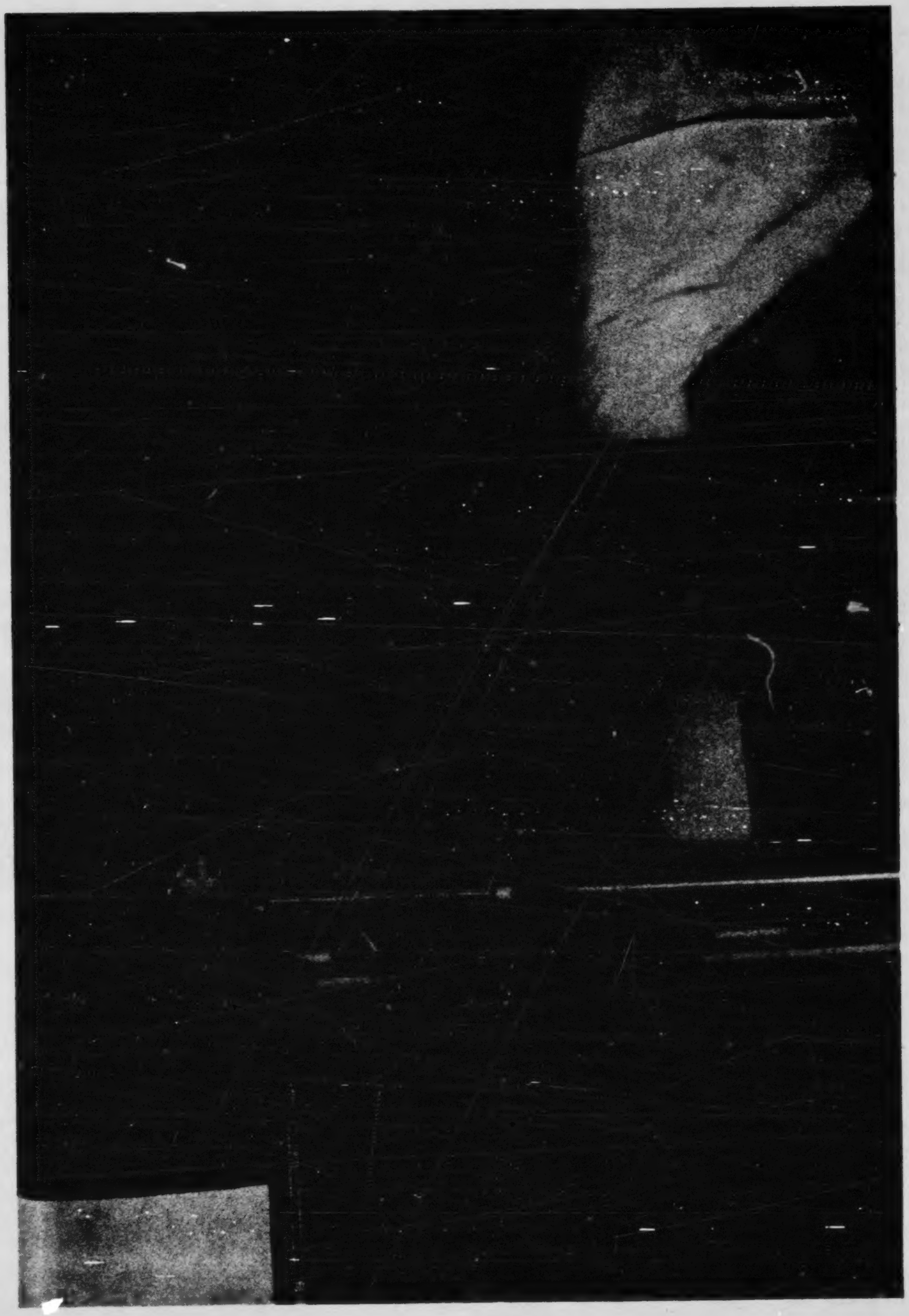
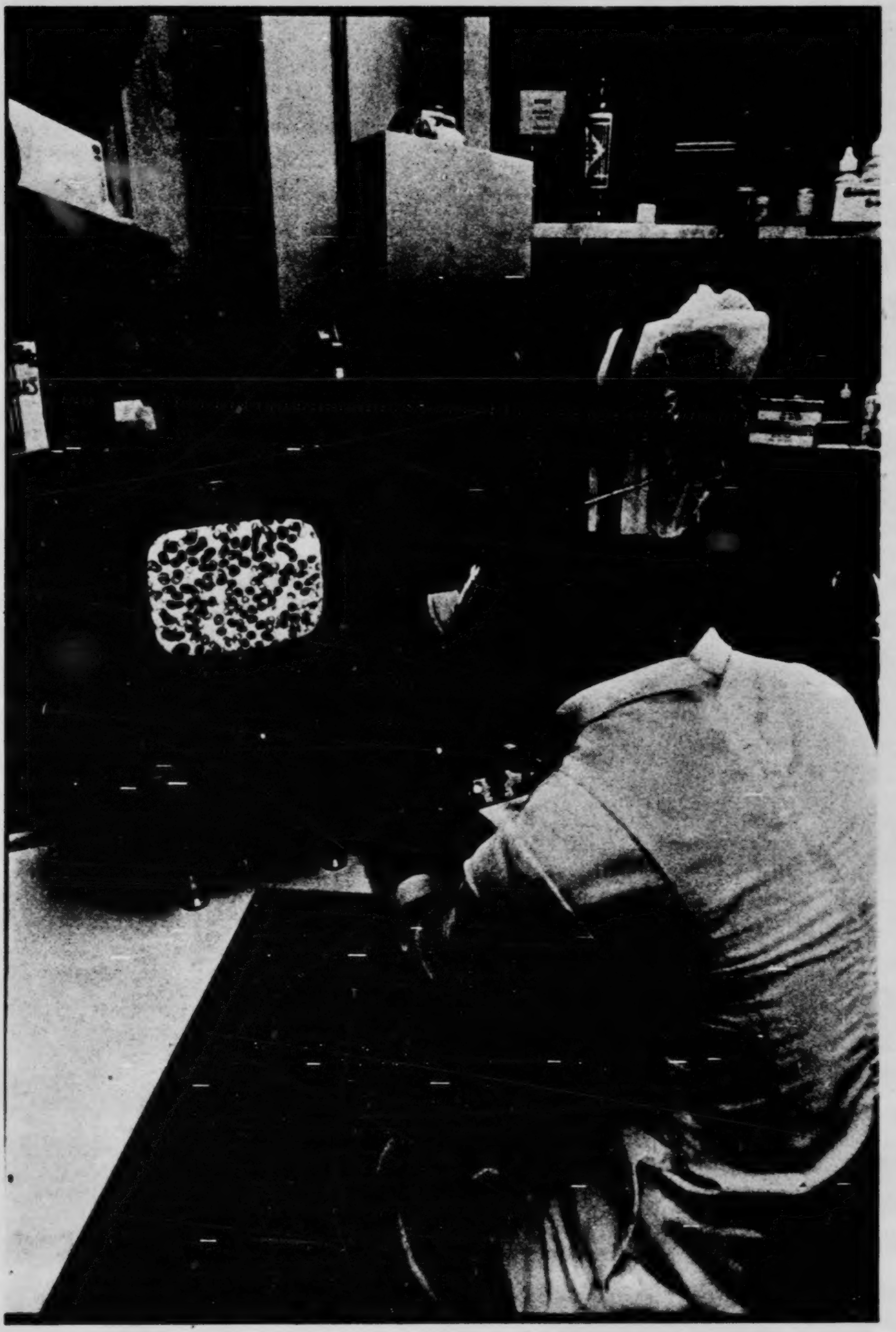


FIGURE 8



CHAPTER II

HISTORY: How telemedicine began and why; development from 1959 to 1974. The three pioneer locations, University of Nebraska, Massachusetts General Hospital, Dartmouth Medical Center ... Federal initiatives, 1972-73; eleven new telemedicine projects, ten new locations.

The history of telemedicine is not long, but it is instructive. Since telemedicine projects were initiated to deal with different problems and different anticipated outcomes, the projects cover a broad range of possible telemedicine experiences and goals. In this chapter the histories and rationales of some projects are considered; later in the book the operational aspects of problems, current utilization, and evaluation of some of these same projects will be described in additional detail.

University of Nebraska/Nebraska Psychiatric Institute

The first telemedicine link,in Omaha, connected two institutions across the street from each other. In retrospect, the shortness of this earliest span points up the concept of "distance" which telemedicine is said to minimize. Today we see telemedicine links and networks stretching from the space between floors to 250 miles. Physical movement in the same space might require minutes to hours, but the elimination of physical movement apparently has psychological and social implications as well as improved efficiency. It is interesting to note that this first short telemedicine link at the University of Nebraska College of Medicine between the Nebraska Psychiatric Institute (Department of Psychiatry) and the Department of Anatomy was constructed in 1959 chiefly "to confirm and utilize the mutuality of their missions in teaching and therapy, as well as to promote discourse between psychiatry and other medical school disciplines." [1]

This link was initiated by Cecil Wittson, Professor and Chairman of the University's Department of Psychiatry and also Director of the Nebraska Psychiatric Institute (NPI). He selected bi-directional telecommunication because of his positive experience in the 1950s with long-distance telephone consultations and conferences among widely-separated groups of mental health professionals at a variety of institutional levels across Nebraska and inter-state. Furthermore, he saw telecommunication links as one means to overcome real and imagined barriers of space and/or distinction and promote synergy within the larger complex.

A number of teaching and clinical experiments were developed to test this innovative tool.

Medical students in neuroanatomy laboratories viewed televised demonstrations of NPI patients with various neurological disorders. Correlations between disorders and anatomic involvements were seen and discussed via the two-way television link.

Eight psychotherapy groups engaged in a controlled experiment. In four groups all participants were in the same room, while in the other four groups the leader participated by interactive television. Wittson and his colleagues concluded that "on balance, it was found that the personality of the therapist was a far more significant or critical factor than the substitution of the television medium for in-person presence." [2]

Psychiatric patients were successfully treated individually via the television link. Wittson says, "We took a very tough case who required depth therapy over a long period of time, and the psychiatrist never met the patient face-to-face. We found that worked." [1]

Neurologic consultation was attempted, with the neurologist observing gaits, talking with patients, and watching while someone at the distal end of the link did various reflex tests. Wittson says, "He was taking the only kind of history that an experienced neurologist could take, and then using his neurological consulting computer [his trained mind] and coming to the conclusion that 'this patient needs to be sent to the medical center—or does not; this is a simple case of multiple sclerosis, or what have you' and we found that the consultant in neurology could do his consulting very, very well over two-way TV." [1]

Psychodiagnosis and psychological testing were performed satisfactorily, "with somebody to handle the cards." [1]

"Evaluation and therapy in speech impairment were satisfactorily accomplished." [1]

"We tested the ability of a psychiatrist to act as a consultant, and what we did was to bring in some general practitioners who ... had no training in psychiatry, along with their patients. They were on one floor [at NPI] and the psychiatrist would be down on ... [another] floor. We found the consultant could help [the G. P. s] and we figured if we could do it from one floor to another, we could do it a hundred miles away." [1]

"We had been bringing people to the Institute for in-service training. We felt that this was a costly and time-consuming thing. There was a good deal of resistance on the part of the administration [of distant institutions]. It was disruptive of schedules. [We concluded that] we can do this long distance. We applied for and got the first grant NIH [National Institutes of Health] made for long-distance television ...to Norfolk [112 miles away]. [1]*

The State Mental Hospital at Norfolk was typical of many institutions of its type. The staff consisted of three psychiatrists, two of whom served also as administrators, [3] one general practitioner and three shifts of seven nurses, as well as a number of attendants to care for approximately 1,000 patients. The staff had little access to consultation, continuing education, and in-service training; the NIH (NIMH) seven-year grant was seen as a means to remedy these shortcomings. Its objectives included rapid consultation for diagnosis and treatment and improved services for state hospital patients, improved educational training for the state hospital staff and other professionals and students at the University/NPI complex in Omaha.

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* The Omaha-Norfolk link did not become active until December of 1964. Microwave facilities were not available between the two cities and had to be designed and constructed by Bell Telephone. The contract, a typical ten-year agreement with termination liability, protected the phone company's large investment in microwave equipment.

In 1969 federal funding cuts reduced the project to six years, and the final report on the Norfolk-Omaha link was issued in September, 1970. The report confirms that the objectives were achieved.[4] Several valuable uses of the Omaha-Norfolk link were unanticipated prior to commencement of operations [4, 6]. These uses included:

- Providing the patients from the Omaha area with routine visits with their families.
- Where home situations had contributed to patients' illnesses, mental health workers could give family members a better understanding of the patients' problems and could sometimes conduct family therapy.
- Omaha, with a large number of job opportunities, proved to be a place where significant numbers of released patients could be employed. Television follow-up and counselling in vocational rehabilitation were facilitated. Patients were interviewed and their progress noted by the state hospital counselors with whom the patients had worked in Norfolk.
- Videotape recordings of social work graduate students conducting groups were played back and reviewed in interactive sessions between the NPI instructors and the students, who were gaining clinical experience at the state hospital.
- Because of the acute shortage of psychiatrists at Norfolk, ward administration proved to be one of the most effective uses of the system. Beginning in January 1965 on a 35-bed security ward for women an Omaha psychiatrist used two-way television to talk and work with state hospital ward personnel and patients for 30 minutes each day. He hoped to achieve better patient management through adequate medication and to change the attitudes of the ward personnel, who thought of themselves as custodians rather than as therapists. Monitoring the ward, even at long distance, brought rapid changes in these situations. As the program progressed, three NPI psychiatrists administered ten wards at Norfolk. The total inpatient population at the state hospital dropped from 900-plus in 1965 to 476 in December 1968. The state hospital administration felt that the treatment programs set up by the TV psychiatrists certainly were contributing factors in this inpatient decline, for it became possible to supervise use of new psychiatric drugs and new therapy techniques.
- A continuity care committee was organized to include representatives of county and private agencies and nursing homes in Omaha, the Norfolk hospital administration and social service personnel, and nursing home administrators in the Norfolk area. Their meetings-by-television served as a clearinghouse for the information necessary to provide better care for ex-patients returning to the community.
- Norfolk staff members were able to participate in the Nebraska Psychiatric Institute's Visiting Lecture Series given by noted authorities, as well as in weekly conferences and classes.

In January, 1966, sixty mentally-retarded male and female patients ranging in age from 23 to 52 years were moved to Norfolk State Hospital from the over-crowded State Home for the Retarded. Frank J. Menolascino, a specialist in mental retardation, supervised those patients' care via the two-way television link, while he remained active on the staff of NPI in Omaha. Dr. Menolascino's first task was to educate the staffs in charge of the units on the special problems of the retarded. A home-like atmosphere was created in the two wards. Recreation and vocational rehabilitation programs were instituted. The patient group was increased from sixty to ninety-two and eighty-one patients were able to be discharged to nursing and rest homes as well as sheltered workshops in their home communities. The two-way television continued to be used to coordinate the orderly transfer of retarded patients from the State Home to Norfolk.[4,6]

Several conclusions were drawm from the Norfolk-Omaha experiment:[4]

- Installation and operation of relatively inexpensive television equipment was accomplished by semi-trained technical personnel at the state hospital under the supervision of a qualified engineer in Omaha.

- Transmission was very reliable. Down-time due to transmission failure was less than 24 hours over 5 years.

- The system was well accepted by staffs of NPI/UN and Norfolk State Hospital, as evidenced by continued and increased use once the novelty had worn off. By the time the project terminated the system was in use from 45-50 hours per week. At the state hospital the concept was particularly well-received by first-line patient care personnel. Although NPI-UN had far greater resources, there was much that their staff and students also learned from the experience.

- Picture and voice communication between professional and professional and professional and patient built friendship and trust, and improved inter-institutional relationships.

- Experience substantiated the claim that two-way television could help the patient function outside the hospital, in the community, by supplying psychiatric and other professional support and by using new therapy techniques. Further, two-way television could help maintain the patient in the community by improving placement and continuing follow-up. During the five years the project actually operated, the patient population at Norfolk was reduced from approximately 1,000 to 476.

- Due to the drop in population, five buildings and ten wards were closed at the state hospital. Concurrently, activity at the Northeast Mental Health Clinic, an outpatient facility located at the State Hospital, increased.

- Continued and expanded use of the link, the generally enthusiastic response to it, and the effects noted would seem to indicate that the project filled a real need.

Dr. Wittson sums up the Omaha-Norfolk experience, "I think it had a great symbolic effect. The Nebraska Psychiatric Institute became more a part of the state system than any similar institution I know of. As one result, Nebraska may well become the first state to do away with state mental hospitals.[1]"

In its first— and thus far, longest— phase, from 1959 to 1972, telemedicine saw little interaction among its practitioners. Pioneer telemedicine developers came to the idea from their intuitions that bi-directional audio-visual communication could be addressed to perceived problems and needs. In 1957 Wittson employed a biomedical communication specialist, Reba Benschoter, to help systematize and implement his ideas. By the time the final report on the Omaha-Norfolk link was written, Dr. Wittson had become Dean of the Medical School, then President of the University of Nebraska Medical Center. Today, although retired from the University of Nebraska, he serves as a full-time consultant to a large architectural firm, developing new health-care concepts to be used in the initial design of community and industrial projects. Mrs. Benschoter, now Director of Biomedical Communications at the University of Nebraska Medical Center is a leading experimenter in bi-directional television, principally in the instruction of health care professionals; she has been a key figure in more recent telemedicine projects based on Omaha, the Nebraska Veterans Administration system, and the University of Nebraska Slow-Scan experiment, both reported in Chapter Four.

Massachusetts General Hospital (MGH) — Logan Airport

Kenneth Bird became interested in telemedicine for reasons quite different from those which motivated Wittson and Benschoter. In 1962 a freak accident occurred at Boston's Logan Airport. At take-off, an Electra prop-jet ran into a rising cloud of birds which had swarmed on the runway. It crashed just off the end of the runway in relatively shallow water. Radio broadcasts of the accident lured hundred of spectators to the scene and the resulting traffic prevented emergency vehicles from reaching the airport. Many of the injured who might have been rescued drowned in the shallow water or died from the effects of shock and exposure. As a result of the tragedy the Massachusetts Port Authority contracted with Massachusetts General Hospital to staff a new medical facility at Logan Airport. Dr. Bird became the Director of this facility.

During its second week of operation the nurses at the Logan station called Dr. Bird at Massachusetts General Hospital to report that a 60-year-old female patient had tripped and fallen. Her pain was so severe the nurses felt she should not be moved without expert consultation. At this point, Dr. Bird felt very acutely the need to see patients at the medical station when neither he nor another physician was present. He thought about the possibility of acquiring a live television interconnection and went to the United States Public Health Service for assistance. They invited him to submit a grant application for a system of telediagnosis. At this juncture, Dr. Bird remembers that, although he could see great advantages in such an idea, he was concerned about its acceptance both by patients and professionals, but these fears later proved groundless. Nevertheless, a grant was applied for and approved. Dr. Bird found his biggest problem was finding microwave channels acceptable to the Federal Communications Commission, and it was not until April of 1968 that the microwave link, after many delays, was finally in operation. Perhaps by reason of its novelty and the circumstances of its origin, or perhaps because it has been the source of more controlled and scholarly studies than any other telemedicine system, the MGH-Logan link has become the best-known of all telemedicine projects in the U.S.

Dr. Bird probably is responsible for making the word "telemedicine" part of our vocabulary, although his earliest reference to bi-directional television for medical purposes was "tele-diagnosis."* Dr. Bird defines telemedicine[7] as "the practice of medicine without the usual physician-patient physical confrontation or ... the practice of medicine via interactive television (or by means of any interactive audio-video communication system)."

The success of the MGH-Logan project led to the establishment of the Massachusetts General Hospital to Bedford Veterans Administration Hospital telemedicine link in March of 1970. (See below.) The two MGH links together comprise a network which frequently interconnects all three locations; the network and its separate links remain in active and constant use. (See Chapter Four.)

Dartmouth Medical Center - Claremont General Hospital

In December 1968, telemedicine activity began between Hitchcock Hospital at the Dartmouth Medical Center, in Hanover, New Hampshire, and Claremont General Hospital, a community hospital 25 miles to the south, in Claremont, New Hampshire.

The initial project was funded by the National Institute of Mental Health (NIMH) and "was designed to evaluate: (1) the utility of television as a medium of communication in psychiatric interviewing and consultation at a distance; and (2) the effectiveness of readily available psychiatric consultation as an educational program for physicians in the community who would not ordinarily take advantage of formal post-graduate psychiatry courses."[8]

It is well to remember that by 1968 there was a great deal of innovation and change both in methods of treatment and contact with the types of patients who previously had been assigned to state hospitals. New drug therapies had begun to help severely depressed patients and others whose diseases formerly required long-term custodial care. These new therapies allowed mental hospitals to discharge large numbers of patients, but it was well understood that most if not all of them would require ongoing supervision and possibly short-term hospitalizations. As a result, much of the burden of care for ex-mental hospital patients as well as new cases was to fall on new and expanded decentralized mental health clinics, or on psychiatrists, other mental health professionals, and family physicians. The Dartmouth-Claremont link was set up primarily to serve the consultative and informational needs of non-physician mental health workers and family physicians.

The Dartmouth staff for the project consisted of Robert J. Weiss, the Project Director; Charles Solow, the consulting psychiatrist (occasionally assisted by other psychiatrists on the Dartmouth staff); Bernard J. Bergen, a sociologist; and Charlotte J. Sanborn, the project's coordinator and its only full-time staff member.

Mrs. Sanborn recalls the problems in getting the project accepted by the local Claremont physicians and the gratifications in its operation and final results.[9]

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* The grant proposal for the Logan-MGH link was titled, "Tele-Diagnosis: A New Community Health Resource." Later, when the Bedford V.A. Hospital-MGH link was founded, it was titled "Teleconsultation: A New Health Information Exchange System." However, in reports and other documents referring to the two links, the word "telemedicine" is used throughout.

The project was geared toward arranging interviews with the physician's psychiatric patients or patients with emotional problems. It was also geared toward their managing the patients locally without having to ship them off to the State Hospital. Mrs. Sanborn goes on to describe some of the physicians' reactions as well as the philosophy of the program as it emerged.

"I went and talked with them: 'How many patients in your practice have emotional problems and how many of these do you think you'd like to have some help with?' and I got answers like: 'Why should I bother getting help from a psychiatrist? All the patients I see come from the State Hospital. They are loaded with medication. They can't walk. Hell, I can do better than that just reading the P.D.R. [Physicians Desk Reference of current drugs].'"

"And then some of them would say, 'Well, I'm leery about medication because I'm not really sure of it,' since the medication appeared to be useless or harmful. So they consistently underdosed whenever they did use a psychotropic drug and they didn't know how long to use it. They had no idea that some anti-depressants took three weeks before they were effective and why, and what things to look for."

"I found that one of the big bug-a-boos was not being able to get any feedback from psychiatry and many of the G.P.'s said things like, 'Well, we thought that this was part of the game, that psychiatrists never put down on paper what they did. You send a patient to a surgeon for consult and you get a note back. You send a patient to a psychiatrist and you don't even get the patient back. They leave you with nothing. They don't give you any feedback and the patient all of a sudden shows up in your office and you don't know what's been done with him.'"

"But even if you weren't sure whether they wanted to be practicing psychiatrists, you did indeed know they wanted help and would like to keep their own patients in the community. So what we did was to say any kind of referral was appropriate. Whatever you deem you want to bring in is fine. We're not going to tell you what is or isn't appropriate."

"I felt that one of the things that would make it fly was to indeed get within 24 hours a copy of the consult back to the physician, indicating what went on, what treatment plans were made—just the whole thing. They then would have a copy they could indeed refer to, and I think it was one of the biggest factors in their acceptance."

But the way the system worked often involved the family physician directly and personally. "We had a beeper on Dr. Solow, who was the psychiatrist on call most of the time. It was fixed so that all a physician had to do was dial Hitchcock Hospital and ask for the TV psychiatrist. The switchboard would beep Dr. Solow and he would pick up the phone and make an appointment for whenever—if it was right now they wanted to see him, then they saw him right now. If it was tomorrow afternoon at 2:00, that was what was done. The time was mutually agreeable to both doctors and the patient. Then the physician would bring the patient down to the waiting area and he would go in, talk to the psychiatrist briefly and tell him what he thought was going on and why he was bringing the patient to him. He'd bring the patient in, introduce him to the psychiatrist and then he would go into the other room adjoining it, with double monitors so he could see and hear both sides of the transaction. He could not talk because there was no microphone. And he was not seen either. But he would sit through and see what was going on in the psychiatric consult. 'What does indeed go on when I send a patient to a psychiatrist? What is the big myth in psychiatry? What do they do that I cannot do?' And I think they learned more from sitting in and then getting a reinforcement of what happened when they got the consult report in a day or two. In the meantime, Dr. Solow would say to the patient, 'When you and I are through talking, Dr. So and So and I will discuss your management and your treatment and your medication and so on. And he'll be in charge of you.' He would also describe to the patient, 'Look, the monitor you see in front of you has a camera on top. If you hear a whirring noise occasionally, that will be me moving the camera.' And then he would play with it and say, 'Look, this is what is going to happen.' That was fine and the interview would proceed. After the patient left, his physician would often go back and talk with Dr. Solow. Then, maybe at the end of the week, Dr. Solow would call up and say, 'Okay, how's the patient doing? Did he have any repercussions or what have you?' And if not, then he would say, 'If you have anything, let me know and if your patients seem to have a problem, just call me again.' Sometimes he'd see the patient again in a couple of weeks. Sometimes he would just see the physician."

"After a while, we instituted a series of conferences about patients. If the physicians had particular or general problems they could discuss them with a psychiatrist, maybe once a month and they would come in and sit down and say, 'I have this kind of thing going, or this patient is on this medication, what should I do? Should I cut it back? These are the things that are going on.' Dr. Solow would say, 'Well, I guess in this instance I'd like to see the patient and in the other instance there's no need to.' This worked out quite well." *

The project also was involved with the needs of local mental health workers. Mrs. Sanborn recalls,[9] "The Sullivan County Mental Health Clinic opened up [in the Claremont General Hospital] during this time. There was just one social worker down there part-time and a psychologist, so they got into this system as well; some physicians would refer to the Mental Health Center and then the Mental Health Center bought psychiatric time over the TV. Dr. Solow was also their staff psychiatrist so he didn't have to travel down. He'd just turn on the TV. I think the crowning glory, the aspect that says it really worked, was at the end of this time, the Sullivan County Mental Health Center was given a choice of having a part-time live psychiatrist or to continue with the TV and they chose to continue using the TV, and they still do. It's very handy for them because they really have a 24-hour coverage while most traveling psychiatrists go and spend a half a day a week or maybe one day at a clinic and that day includes travel time which is usually two hours in both directions, so they end up spending four hours in the clinic and all they usually do is sit in and listen to staff presentations and say, 'Okay, I guess this medication should be changed. Maybe you should do this with him or that.' They've really been getting a lot better coverage. The patient is getting a lot better care."

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* Between December 4, 1968 and December 4, 1969, there were 199 consultations, 142 with new patients and 57 for follow-up consultations. Most of these were initiated by the twelve general practitioners and one internist practicing in Claremont. Forty-five of the new cases were initiated by the mental health clinic. Despite initial anticipations to the contrary, sixty percent of the patients referred had no previous psychiatric contact of any kind. It may be concluded that the local physicians had lost a good deal of their skepticism concerning psychiatry. Physicians continued to maintain interest in their patients and took over the treatment of those whom they were able to manage (approximately 70 percent of patients referred).[8]

Mrs. Sanborn also notes that there were no admissions to state mental hospitals of patients of Claremont area physicians, after the psychiatric projects started. This was not due entirely to the telemedicine link. The reason for establishing local mental health clinics, after all, is to provide consultation and treatment as well as continuing care. What is noteworthy, here, however, is that major psychiatric consultation was and is provided to the Sullivan County Mental Health Clinic via the two-way television link. Physicians have continued to use the Dartmouth-Claremont TV facility for psychiatric consultations since initial funding terminated in 1970. In general, these family physicians have become much more astute in recognizing symptoms of mental and emotional disorder, and their management of patients on psychotropic drug regimens has, according to the psychiatric staff at Dartmouth, been unexceptionable in most cases. By the end of the first year of operation of the Dartmouth-Claremont link, its principals stated, "Experience gained to date ... seems to justify the conclusion that two-way closed circuit television provides a means of psychiatric interviewing at a distance, in the setting of community medical practice, with a diagnostic and therapeutic effectiveness approximating that which is obtainable in face-to-face interviewing."[8]

Today, this link has expanded to the "Interact" network which serves communities in both New Hampshire and Vermont, and joins the Medical Center of the University of Vermont with the Dartmouth Medical Center in providing service. (See Chapter Four.)

Nebraska Veterans Administration Network

In December, 1969, three Veterans Administration Hospitals in Nebraska began to use telemedicine links, drawing on the experience that had been gained from the work at the University of Nebraska Medical Center. Using microwave links supplied by the telephone company, VA hospitals in Omaha, Lincoln, and Grand Island were joined together by two-way television. The entire network was joined by cable to the University of Nebraska Medical Center and the Nebraska Psychiatric Institute.

The primary purposes of the Nebraska Veterans Administration system differed from those of the previous telemedicine installations. Where the earlier telemedicine links had been directly related to specific local or regional problems in delivery of health care, this one evolved in order to provide better continuing education for the staffs of the V.A. hospitals, as well as to permit consultations on an as-needed basis and to facilitate conferencing among the personnel of all three hospitals on matters of policy, interpretation of guidelines, and administrative matters.

(A detailed description of this active project is found in Chapter Four.)

Massachusetts General Hospital - Bedford (Mass.) Veterans Administration Hospital

Regular interactive transmission between MGH and the VA Hospital at Bedford began on March 30, 1970. In its first six weeks of operation more than fifty health professionals at Bedford had taken part in patient oriented transactions.

The major objectives of the link were to develop the electronic circuitry and supportive resources to demonstrate the feasibility of Teleconsultation, and study and cultivate the factors which foster this type of inter-professional consultation.[10]

(A more detailed description of this active project is found in Chapter Four.)

Because the Bedford facility is chiefly devoted to long-term care of patients with severe mental and neurologic disorders, the orientation of professionals utilizing this link has been similar in many ways to the orientation of the early Omaha-Norfolk project. Those involved in the project are concerned with psychiatric assessment and consultation, group therapy, teaching medical students at Massachusetts General as well as rehabilitation therapy. There are differences between the services provided by the two links. There is a considerable emphasis in the MGH-Bedford link on providing medical consultations in several specialty areas. There is not the emphasis on using the link to do patient follow-ups or to provide family contacts, as in the Omaha-Norfolk experience. Since Bedford is thirty miles from Boston and Omaha is more than a hundred miles from Norfolk, this may suggest a correlation between the needs and the distances involved. Professional staff at Bedford VA Hospital is far larger than the staff at Norfolk State Hospital, and acceptance of the telemedicine mode by physicians at Bedford seems to be less than what was experienced at Norfolk.

Whether size of staff or distance between institutions correlates with acceptance has not been studied. It does not appear, however, that interaction among physicians at Bedford substitutes for the contact with specialists which is made available by the link to MGH. On the contrary, it is reported that staff interaction at Bedford is not maximized. Possibly the practice attitude of open critique of colleagues' work found in a tertiary teaching institution and the attitude of more insular "ownership" of practice in a secondary care institution are brought somehow into conflict by the television interface.

It is clear that telemedicine, as any significant innovation which promises or threatens to make changes in traditional norms, has and will continue to have opponents and detractors. Wide acceptance of the concept will depend on satisfactory answers to many questions. It seems, however, that a very important set of questions about acceptance arises in the context of actual involvement with the medium. This project, linking two institutions which together present a fairly typical mix of problems, needs, and opportunities in the kinds of practices they represent, has accepted responsibility to try to resolve the questions which telemedicine provokes in their setting. How this is being accomplished is touched upon in later chapters.

New Hampshire/Vermont Interactive Medical Television Network

In June, 1971, the Lister Hill Center for Biomedical Communications signed a contract with the Dartmouth Medical Center which provided for interconnection with the University of Vermont Medical Center at Burlington and the Central Vermont Medical Center at Berlin, just outside Barre, Vermont. With the existing link between Dartmouth and Claremont, New Hampshire, this represented the first interstate telemedicine network. The joining of two medical school centers opened up a wider spectrum of professional exchanges and educational opportunities than had been available previously. Future expansion was planned to include the Rockingham Memorial Hospital in Bellows Falls, Vermont, the Windsor State Prison in Windsor, Vermont and the New Hampshire Vocational Technical College in Claremont, New Hampshire.

The construction of microwave links to Burlington and Berlin was completed in October of 1972. Operations of the expanded network are detailed in the description of "Interact"* in Chapter Four, below.

Telemedicine's first period came to a close in 1972. It was characterized by the independent emergence of interactive television in three separate locations. Each project discovered that positive benefits, actual or potential, justified the money and effort that was expended. Each continued in operation or fostered new projects which drew on previous experience. Telemedicine projects remain active in all three locations today, even though funding has become less available than it was during the more expansive Sixties.

Even though Massachusetts General Hospital conducted a number of studies of various aspects of telemedicine, these were not widely disseminated, and there was little exchange of information among the three locations. As a result, telemedicine was relatively unknown within the health professions and substantially ignored as a serious alternative to delivery of health care and professional education.

1972 marked the beginning of expanded interest in telemedicine's potential.

Federal Initiatives, 1972-73: Eleven New Telemedicine Projects

Rising costs of health care, increasing demands on the health establishment, and maldistribution of health care resources have aroused widespread concern. Recognition of the universal right to health care and the difficulties in providing it motivated three offices of the federal government to initiate ten of eleven new telemedicine projects during 1972-73. Eight new projects were funded by the Health Care Technology Division (HCTD) in the Health Services and Mental Health Administration (HSMHA).**

These projects were: Bethany/Garfield Community Health Care Network, Chicago, Ill.; Cambridge Telemedicine Project, Cambridge, Mass.; Case-Western Reserve School of Medicine Anesthesiology Project, Cleveland, Ohio; Illinois Mental Health Center Picturephone Network, Chicago, Ill.; Lakeview Clinic Bi-directional Cable Television System, Waconia, Minn.; Mount Sinai-Wagner Bi-directional Cable Link, New York, N.Y.; New Hampshire/Vermont Interactive Medical Television Network "Interact" (projects were added to the existing system); and University of Nebraska Medical Center Slow Scan Radiology Project, Omaha, Neb.

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* "Interact" is the name by which the New Hampshire/Vermont Interactive Medical Television Network became officially known in 1973.

** HCTD has since become Department of Health, Education, and Welfare; Public Health Service; Health Resources Administration; Bureau of Health Services Research; Division of Health Care Information Systems and Technology, but throughout this report it is referred to by the name it had at the time the projects were started.

The Office of Economic Opportunity funded Rural Health Associates: Interactive Medical Microwave Television, Farmington, Maine.

The Regional Medical Program (specifically, Maine's Regional Medical Program), funded Blue Hill-Deer Isle Telemedicine Project, Blue Hill, Maine.

The Cook County Hospital, Department of Urology Picturephone Network, Chicago, Ill., was self-funded.

The Lister Hill Center for Biomedical Communications (N.H./Vt. "Interact" System) and The Veterans Administration (Nebraska V.A. Hospital Network, Mass. General-Bedford V.A. Hospital Link) continued their funding of the pioneer projects during this period.

The National Science Foundation solicited proposals which aimed to clarify public policy issues raised by new telecommunication modes and funded a telemedicine project which would begin serving Miami, Fla. correctional institutions in 1974. HEW's Experimental Health Service Delivery Systems Division made funds available for the Jacksonville (Fla.) Experimental Health System to build a new telemedicine network. NASA prepared plans for satellite telemedicine systems in Alaska, the Northwest, and the Southwest to serve health care needs of the indigenous Alaskan and Amerind populations as well as for students and health workers in remote rural areas. The Veterans Administration planned new telemedicine networks and links among various of its hospitals and began investigating involvement in regional systems which would include non-VA hospitals.

Interest in the ways in which interactive television could serve societal needs had been spurred by reports, surveys, and speculative articles by respected observers.[11] The body of this work was not devoted solely to medical and health care needs. Indeed this new tool was seen to address questions of education, citizen participation in government, new population deployment, and almost every problem area in modern life except the then unheralded depletion of energy resources.

On April 6, 1971, the Secretary of the Department of Health, Education, and Welfare, Elliot Richardson, in a memo addressed to Assistant Secretaries and Agency Heads,[12] noted that forms of telecommunications other than the mass media could "cut costs and improve the efficiency of many of the services we provide ... in such areas as child development, basic education, occupational training, continuing professional education, population education, preventive health ... especially nutrition, alcoholism, and drug abuse ...." In this memo the Secretary indicated his interest in moving ... "forward more effectively in our cooperation with NASA especially with regard to proposed experiments in Alaska and the Rocky Mountain Region."

With the advent of cable television in New York City, it was forecast that most of the nation's cities would be wired by 1980. Promising forty or more channels with bi-directional capacity, it was widely assumed that cable systems would implement "the wired nation" concept. Then institutions and individuals would have access to vast stores of information and culture, educational opportunities, and manifold services from burglar alarms to health care. Telecommunication would obviate the need for much obsolescent transportation along with its attendant pollution and energy-consumption.

The 2-year period would end wiser than it began. Cable television alone never could become the panacea many hoped it would be, yet the "wired nation" concept remains viable. It is understood that the nation's telecommunications will not be provided by cable television but will include cable television along with other forms of transmission, some still to be developed.

Leadership toward specific goals and experimentation in the area of delivery of health care and related service activities came most visibly from HCTD, although the agencies named above contributed intellectually and monetarily. First, HCTD funded the eight projects noted above, in the amount of $1,158,056. The first seven were funded following responses from 22 prospective contractors to a Request for Proposal. This RFP required that experiments in telemedicine be implanted within existing systems of health care (as opposed to creating health care systems which would be developed to take advantage of technological capacities.) This requirement was modified to enable experiments in dermatology and speech therapy utilizing the Dartmouth-Claremont and Burlington-Claremont links of "Interact." This meant that the bulk of funds was spent for technology because existing staffs would, in the main, utilize the telemedicine facilities. Hierarchical systems were favored in order to facilitate the flow of medical expertise from centralized teritary facilities through secondary community institutions to primary care clinics.* Because HCTD's orientation is to health care, all these experiments were devoted to delivery of services to patients. It is noteworthy, however, that in-service training and education was seen to occur in varying degrees of significance in all the projects as an apparently natural, integrated outcome of consultation and supervision, because professional interaction is basic to the communication.

The range and variety of projects funded by HCTD was broad. Three projects dealt with rural populations, while five were in urban settings. Six projects were based on private non-profit institutions, two on public institutions, and one on a private for-profit group; one private non-profit institution served a public clinic.

The aim of HCTD's funding effort was to gain "clinical impressions" of the utility of visual telecommunications in improving the access, quality and cost of health care systems. HCTD referred to its overall program in communication and transportation for health care delivery systems as the Logistics Program. (As of this writing transportation work is still in the planning stage). The Logistics Program was divided in three phases:

Phase I would be the exploratory phase to discover promising applications of communication technology for study in Phases II and III.

Phase II would generate information needed by systems engineers and decision makers to implement Phase III projects. It would develop data in three areas: (1) estimation of amount and frequency of specific types of interactions, (2) analysis in technological, manpower and other terms, of the trade-offs possible in each specific type of interaction, and (3) estimation of technological improvements or developments which could affect the data from (1) or (2).

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* In actual practice, none of these experiments served all three stages of care; four projects connected tertiary and secondary institutions, three connected tertiary and primary institutions, and two connected secondary and primary institutions.

Phase III, the ultimate objective of the program, would analyze and create cost-effective communication and transportation networks for a number of different health care delivery system modes.

HCTD's second leadership initiative came about as the result of experimentation in reporting procedures. It was decided that, rather than submitting written interim reports, the contractors would meet periodically and present oral reports, augmented by audio-visual materials, chiefly videotapes, and brief written summaries. The objective was to share experience and observation among the various groups involved and to encourage synergism in discussion, criticism and analysis. There were five HCTD-sponsored meetings of its contractors, including one "evaluation workshop," in 1972 and 1973. The HCTD conferences were significant in that they resulted in productive definitions of the actual issues in development of interactive telecommunications.

The first conference was held in Hanover, N.H., July 27-28, 1972. None of the eight projects was yet operational and representatives of the seven projects then funded* presented progress reports on technical and evaluation planning. In addition to the HCTD contractors, other groups using or planning two-way television communication were in attendance, as well as observers with various interests in the telemedicine mode. Technical problems were aired and discussed. Since evaluation strategies were in varying stages of development an attempt was made, as it would be made in subsequent meetings, to establish clear guidelines for evaluation. Although there was general agreement about the objectives, a precise means of evaluation was not forthcoming for most of the projects.

The second conference was held in Boston and Cambridge, Mass. September 28, 29, 1972. This conference allowed the contractors to observe the Massachusetts General Hospital links to the Bedford Veterans Administration Hospital and the Logan Airport Medical Station. None of the new HCTD projects had become operational as yet. Although most had expected to be functioning, they were experiencing delays in technical implementation. Principals from the pioneer systems and experts in technology and communication were able to offer suggestions to the contractors toward the solutions of their technological and evaluation problems.

The third conference was held in Washington November 30 - December 1, 1973. The purpose of this meeting was to present technological developments that could influence future directions in delivery of health services via telecommunication. Presentations were coordinated by the Director of the Committee on Telecommunications of the National Academy of Engineering. These presentations included: new technologies in broadband communication; configurations and capacities of cable television; Federal Communications Commission regulation of cable television pertinent to allocation of channels for service use; a computerized system (TICCIT, Mitre Corporation) providing multiple terminals for information retrieval and interaction; and medical information systems utilizing existing and contemplated telecommunication networks.

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* University of Nebraska Slow-scan project was approved later.

By the time of the fourth HCTD meeting, which was a workshop held in Chicago, March 29 - 30, 1973, all the original contractors, with the exception of Illinois Institutes of Mental Health, had begun operations. Without exception, utilizers reported positive reactions from patients and professional staffs who had thus far used the systems. However, it must be remembered that these utilizers had positive reasons for wanting to try telemedicine, so whatever novelty effects are inherent in new ventures were presumably operating here. There was general agreement that ultimate worth of telemedicine in each of the several applications would be proved only after several aspects could be quantified, but utilizers (with the exception of principals of the Cambridge system, who had set up an experiment to test certain hypotheses) felt that available evaluation methods were inadequate in instances when

- instruments had been devised that required more than minimal effort (in tabulating, answering questions, checking off appropriate descriptions of activity, indicating lengths of times involved) staff response was negative. Filling out forms was taking too much professional time, and the data were inconsistent;
- instruments to measure what users perceived actually to be occurring had not been devised; the nature of the experience seemed to contain variables which were insufficiently isolated and defined and therefore could not be measured;
- "gut reactions" were felt to be of considerable validity and there was no way such reactions could be measured;
- experience with the medium had barely begun, had not achieved anything like steady states, and tended to vary with users, types of activity and different mixes of both;
- the technology was implemented differently for each application, was ill-understood in terms of its capacity, was perceived differently by different utilizers, and tended to facilitate or encumber transactions differently, according to location, user, and professional-professional or professional-patient mix.

What seems to have been taking place was the dawning realization or confirmation that a new communication technology does not become a simple addition to facilitate traditional tasks, and therefore cannot be easily quantified in terms of task-improvement. Experience showed that:

- A communication technology changes the communication among the people and puts data in a perspective different from what happens face-to-face. ("Let me see" is different from picking up and looking at, different from moving oneself in order to see.)
- Dependence of a physician on a distant professional, such as a nurse or other physician, to report, explain, manipulate, etc., engenders a different relationship from that found in traditional face-to-face encounters.
- Communication technology for specialized purposes is in its infancy. The HCTD contractors typically were using equipment manufactured for standard television communication. Two "special adaptations" in limited use—remote control of distal cameras, and the electronic stethoscope—were, respectively, clumsy to

operate and unreliable as to quality. Compared to anticipated future equipment, the communication equipment was primitive.

This fourth HCTD meeting also brought into the open a sizeable area of disagreement between telemedicine practitioners and disinterested observers from social science and systems analysis disciplines. The latter contended that significant factors of cost, quality, and access could be isolated and quantified by the various telemedicine systems, and were not persuaded by the arguments noted above, while the practitioners found few of the suggestions made by these observers currently applicable to their projects. In fairness to the observers' position, it should be noted that most of them had little if any exposure to the actual situations encountered by practitioners, so the discussion tended to deal in generalizations.

Against the background of problems which surfaced at the Chicago workshop, the fifth meeting in Minneapolis, Waconia and Jonathan, Minn., October 1-2, 1973 attempted to isolate and identify problems of utilization and evaluation. In general, the participants again expressed confidence in the value of the telemedicine concept. Progress reports on some of the projects were given by participants.

Bethany Brethren-Garfield had installed counters on its Picturephones, giving clear information on traffic volume, and had moved some Picturephones from low-utilization areas to others where experience indicated greater use would be made of them. Armed with positive and negative use data, the evaluator had embarked on a series of depth interviews to discover reasons for the varying use of the Picturephones in different locations.

Cambridge Hospital principals reported that their observation of randomized telemedicine/telephone consultations showed that telemedicine required more time but resulted in more satisfaction on the part of participants, and probably better training of some clinic nurse practitioners. Also, they remarked that the placement of the television equipment had had a negative impact, requiring physicians to travel a number of floors and "had put telemedicine at a disadvantage."

Case-Western Reserve participants announced a systems approach to evaluation, utilizing a Delphi model to assign value weight to several factors. They also noted that the anesthesiologist-supervisors were taking advantage of the training opportunities available via the medium.

Lakeview Clinics reported that a shutdown for repair of its system had resulted in technical improvement in transmission. However, evaluation plans had been hampered not only by the shutdown but also because of the difficulty of obtaining time-studies similar to those which had been done prior to system emplacement. Chiefly due to the shutdown, most physicians had not become frequent users of the system, although their reactions when they did use it were generally favorable. Because of Lakeview's rural location, it was strongly urged that the clinic attempt to gather data on savings in time and travel for professionals and patients.

Mount Sinai-Wagner reported steadily increasing use of its system with favorable reactions from nurse practitioners, medical center professionals, and patients. Additional specialist areas were being tapped for consultations. It was pointed out, however, that the city health department physicians who visit the clinic tended to ignore the link and did not request consultations on it. An interesting phenomenon was noted in regard to the screen size of images and the placement of monitors. The clinic staff reported a "face of God" reaction toward the distant physicians. When the monitors were placed lower and the images were reduced in size, this incipient problem of deification was alleviated.

The New Hampshire/Vermont "Interact" principals reported favorable outcomes in both their dermatology and speech therapy projects. The hospital and local schools in the Claremont, N.H. area, from which patients had come, were interested in continuing both services. No particular constraints had been placed on the dermatologist with respect to the amount of time allowed for consultation. Consequently, the physician took considerably more time than in face-to-face encounters. The physician explored the capacity of the system to legitimate going into social and family situations. She also devoted time to explaining etiology and treatment to parents who accompanied their children to these sessions. Principals of this system declared that most of the difficulties they encountered in use of the technology were due to insufficient understanding of the interactive medium.

Discussions of the physician's ability to perform specific physical diagnostic examinations via telemedicine were also conducted at this meeting. The Lakeview Clinic's telemedicine system equipment was used in an attempt to demonstrate points in the discussion, with equivocal to negative results. Technicians, communication experts and experienced telemedicine practitioners were quick to point out that nothing that had been attempted was theoretically impossible or even very difficult, and that most of what had been attempted could, in fact, be done very well on systems more sophisticated than the one at hand.

It was at this point that several participants refused to accept the implication that the difficulties encountered with use of interactive television could be laid to purely technical solutions. The "Interact" principals said that, although the purely seeing and hearing capacities of their system might be superior to Lakeview's, and that superficially they could indeed see and hear satisfactorily, nevertheless there were still great problems in the "clumsiness" with which medical professionals approached the technology. Behind this "clumsiness," they said, lay insufficient understanding of the technology by the users. Although they were convinced that telemedicine worked and was valuable, it would remain suboptimally functioning until and unless professionals became proficient in its use and familiar with its capacities. In the context of the previous workshops which had concentrated on questions of evaluation more heavily than this one, it was pointed out that assessment of cost, quality, and access was being hindered by failure to understand the medium— a failure not solely the province of medical professionals but of all who have used or have seriously contemplated using the medium. This was a point on which the discussants found they could agree with a unanimity approached only by their agreement as to the need for proper evaluation. The session concluded in a consensus on two basic points: First, evaluations must be limited to what can be done pragmatically. Comparisons of base-line or control data with telemedicine-particular data are close to impossible, given the problem in understanding, with its variables that cannot be related or weighed. Specific examples of appropriate evaluation strategies were cited: the gathering of qualitative information that could be tied to quantitative data such as at Bethany-Garfield, and the gathering of related quantitative data such as was suggested for Lakeview Clinic. Second, ways must be explored to bring about productive dialogues between technologists and professional users. It was suggested that, as a start, less-experienced telemedicine practitioners should devote substantial amounts of time in preceptorships at one of the older and more sophisticated systems in order to bring their understanding of the medium to the level of its most advanced practitioners. Also, human factors studies relating to technology and behavior studies relating to interactive telecommunication must somehow be integrated and pursued. The session ended with several participants suggesting topics for such studies: "What does a physician need to see and in what sequence does he need to see it?" "Can a camera be so mounted to take the physician's eye where it needs to go?" "How much information derived from a wide-frequency electronic stethoscope is significantly added to information derived from a traditional acoustic stethoscope?" "How much time does it take for a physician to learn the meanings of the wider range and intensity of sounds conveyed by the electronic instrument?"

The five innovative HCTD conferences accomplished a great deal. They gave a direction and focus to serious consideration of the telemedicine concept. In less than two years telemedicine emerged from something reported as a curiosity—if reported at all—to an alternative in health services delivery that merited careful consideration.

On October 29-30, 1973 the Department of Medical Care Organization of the School of Public Health at the University of Michigan conducted a seminar supported by a grant from the National Science Foundation. These sessions, proceedings of which are to be published in 1974, constructively summarized many of the issues that have been identified in assessment and development of telemedicine and presented the ways in which several disciplines (medical economics, medical sociology, psychology, communication, systems analysis, geography, and telecommunication engineering) could address the issues. Most participants reached certain conclusions: Interdisciplinary studies are needed to address the ramifications of the question, "What do we need to know in order to apply communications effectively in the field of health care?" Engineering, per se, was not a basic problem, but that questions as to how engineering should be applied were fundamental. The feasibility of telemedicine to conduct a wide range of medical procedures had been demonstrated, but work remained to be done to determine what are the minimum communications compatible with successful performance of these and other procedures. Questions about what can be taught and what can be learned via interactive telecommunication need considerable study, particularly since needs in health care might well be as great or greater in the areas of professional and patient education and in-service training as in consultation, diagnosis and treatment. Acceptance of telemedicine by patients and involved professionals would seem not to have been a major problem. Human interaction in the bi-directional medium was little understood and needed considerable study so that interaction requirements could be identified and systems designed to meet them. Finally, the most difficult questions dealt with the social impacts of communications technology on health care and its organization. These questions were numerous, involving issues of value, access, legality, responsibility, acceptance, efficiency, economics, training, class distinctions, and the most fundamental question of all: "What constitutes an optimal health care system?"

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    i. Smith, Ralph Lee, "The Wired Nation," *The Nation*, May 18, 1970, pp. 582-606.

12. Richardson, Elliot, Secretary, Department of Health, Education and Welfare, "Initiatives in Telecommunications," memo, Wash., D.C., April 6, 1971.

CHAPTER III

HUMAN COMMUNICATION IN THE INTERACTIVE TELEVISION MEDIUM

(The Interactive medium defined . . . . Characteristics of Television . . . Physical Properties of Television Communication . . . Psychological Properties . . . . Some Cultural Issues in Interactive Television. . . Observed Phenomena in Telemedicine Interaction ("Something Different is Going on Here") . . . Observed Phenomena Reviewed . . . Symmetry: Some Preliminary Inferences . . . Effects of the Telemedicine Medium on Physicians' Attitudes Toward It . . . Relationship of Professional Users to Interactive Television Technology.)

The Interactive Medium Defined

The word "medium" has several denotations, two of which are operative in interactive television:[1]

- "Any intervening substance through which a force acts on objects at a distance or through which impressions are conveyed to the senses (1595)." "Hence, pervading or enveloping substance; the 'element' in which an organism lives; hence (fig.) one's environment . . . (1865)."
- "An intermediate agency, means, instrument, or channel . . ." (1605).

The latter is commonly applied to "the television medium." The former, broader, meaning is the sense in which we here employ "medium." Thus, there is always a medium in which interaction takes place consisting of all the factors which comprise the shared environment. If we regard both face-to-face and television environments as media, we avoid the notion that there is somehow a "medium" involved in one and not in the other.

In the face-to-face medium we are interacting in a single shared space whether it be a breakfast room or a sports arena. Walls, light, colors, smells, movement, voices and other sounds all are parts of the medium, as are the people in the space and everything they are, stand for, or do. The face-to-face medium contains phenomena which can be perceived by all five senses.

In the telephone medium, interaction takes place in a shared environment consisting of two physical spaces, one experienced by all five senses, the other only be hearing. We may be paying attention to another voice but the "other" space is very much a part of the environment. We are reminded of the total environment by loud clatters, music, or other distractions in the "other" space, or the sudden, unexplained loss of contact with the unseen person with whom we were conversing; our attitudes in the interaction are influenced also by what is happening where we are, whether we are holding the telephone receiver in a booth or a barroom.

In the interactive television medium, we are in a shared environment where both (or more) spaces are seen and heard, but (currently) not susceptible to touch, smell or taste. Furnishings, lighting, voices in both spaces are parts of the medium. Sounds and views originating in the other space do not have the same quality as do those in the space where we are physically, yet the former are fully as much parts of the medium as are their counterparts in the latter. Making value judgments about them neither eliminates them nor says anything fundamental about their effects on the interaction.

The first noticeable difference is that this medium includes a television screen, a camera, a microphone and perhaps some other equipment. But, just as in the telephone medium, these pieces of hardware make interaction different from interaction in other media, not only because views and sounds are different but because of the ways in which they select, modify, and deliver visual and auditory information.

Discussion of human communication systems, per se, lies beyond the scope of this report. It will have to suffice to note that human communication is far more dependent on the humans than it is on the technology. Thayer[2] puts it succinctly: "General systems theory helps to point it up, but a human communication system is not the same as an 'information' system. In an 'information' (read 'data') system, the data are the message. In human communication, 'information' is the product of a human transform of the data. In human communication systems, 'information' is what people do to the data."

Participants in the bi-directional television medium need to understand the factors which make it different from the face-to-face medium in order to optimize its potentials for human interaction and avoid making wrong assumptions about it. One such assumption is that interaction in telemedicine is necessarily "inferior" to face-to-face; another is that it may be made to "duplicate" face-to-face interaction.

Characteristics of Television

This section discusses some of the psychological, technical, and cultural factors that describe human communication via television.

The relevance of these factors to the interactive television medium will be discussed later in terms of specific communication currently observed in telemedicine. Some comments related to telemedicine, however, appear here as cautionary examples.

1. Physical Properties of Television Communication

- Scanning of the image. The television scanning beam of electrons describes the picture as a series of horizontal lines of dots of light. The beam moves from left to right, exciting a series of phosphors to produce luminant dots of varying degrees of brightness in each line. The beam produces 263 such lines from top to bottom of the screen in slightly less than 1/60th of a second, is returned to its original upper left hand corner position and produces 262 lines in a second series of scans. These lines "fill in" the regular spaces left among the original 263, to form a complete single 525-line "frame" of information in 1/30th of a second. The sequence is then repeated. Like motion pictures, the technique depends on viewers' visual retention to cover the gaps in transmission, although film speed is normally 24 frames per second for sound pictures.*

McLuhan[4] has suggested that because television pictures include many gaps and are of low definition, television makes viewers' minds work to supply missing information. This, he feels, accounts for the high degree of participation which television seems to enjoy. No experiment has yet demonstrated the validity of this theory.

- Two Dimensionality of Picture. In both television and film, as well as other "flat" abstractions of "reality," the dimension of depth is effected as perspective with near objects larger than distant ones. The perspective which seems most like actual experience is obtained in the filmic technologies** by the use of lenses which are "medium" in focal length.

Very short lenses (in television, 10 mm to 25 mm, depending on the size of the camera), give the effect of foreshortening the image. A head in the immedite foreground is seen with an excessively large nose; a hand thrust toward the camera is huge, the arm too long, the head and body disproportionately small, while a wall in the background becomes unnaturally distant.

Conversely, very long lenses (1000 mm) seem to pack everything into shallow depth. The outfielder running in after having made the third out seems to be running in place on a treadmill; the stadium wall remains close behind him; cars in five blocks of traffic seem jammed together in less than one block, with the rearmost as large as the near ones.

Quick changes between short and long lenses focused on the same field of view tend to produce effects of unreality or fantasy, can be unsettling, and are often so used in devised or dramatic contexts; these should be avoided unless such effects are desired.

- Frame Size. Cathode-ray television tubes display pictures ranging from about 5 inches to about 30 inches, measured on the diagonal. The larger the screen, the longer the tube, generally speaking. This need for increased depth of the monitor or television set to contain the tube length is the major limiting factor in increasing the size of the screen.

Size of screen is significant in relation to distances between television screens and viewers. Considerations of frame tension (see below) are little influenced by the sizes of current screens because the edges of the frame are always apparent. Proxemic considerations (see below) however, probably are related to the actual size of the image and an estimate of the apparent distance conveyed by that size.

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* Tony Schwartz makes a considerable distinction between the gaps in film and television images. Film is a complete visual image seen from a 50th to a 75th of a second, alternating with a blank screen for about the same length of time. Television is continuous, but at no moment is a complete image on the screen. "With television, the brain must fill in (or recall) 99.999 percent of the image."[3]

** Technologies which (a) project moving pictures on a screen within a frame, and (b) permit editing or change of sequence within the frame.

If a human head occupies the entire screen on a 27-inch tube, it is larger than life-size, or impossibly "close;" a human head, shoulders and upper trunk on a 27-inch tube is smaller than life-size, or "farther away."

Research and development of thin flat-panel television display may produce screens 8 by 6 feet or larger before 1982. Such screens, occupying an entire wall and protruding an inch or less, may introduce totally new psychological factors. Viewing the entire distal space from one angle and life-size images of people may permit one to "look around" in that space and will possibly eliminate frame tension. Conversely, close-ups of people will be huge and in such cases frame tension may be greatly increased.

- Gray Scale of The Black and White Television Picture. (Discussion of color television is more complex. However, the "blooming" effect noted below is similar.) All colors, including black and white, are rendered in relative tones of gray in black and white television. This is because television currently does not reproduce either a true black or a true white.* If total black to total white is calibrated through all intervening shades of gray on a scale of 100, with black at -0- and white at 100, television is limited to the range between approximately 30 to 70; thus all values are compressed within that range.

  If a nurse's white uniform is a major element in the picture, it will be reported at 70, but everything else in the picture will be compressed relatively downward on the scale; the skin tone of a patient will go darker and if subtle highlights are important to "seeing" the patient (particularly one with dark or black skin) these highlights will tend to disappear. The white uniform will tend to produce a dark halo or "bloom" at its edges.

  Automatic light control adjusts camera output very quickly when moving from a dark scene to a light one, or vice versa, and brings overall light intensity to a predetermined level; however, when very light and very dark elements are in the same frame, one will observe the blooming effect noted above.

  Plumbicon cameras tend to "read" light waves in the red spectrum as somewhat darker values of gray than do vidicon cameras, and at a slightly darker value than the red appears to the human eye. This red bias of the plumbicon camera can be advantageous when examining skin lesions and inflammations, or the small veins in the eye.

- Color Values. Color television of the U.S. (NTSC)** standard can reproduce color with a remarkable degree of verisimilitude, but currently requires constant attention by technicians in order to maintain stability. The European systems (SECAM and PAL)*** are more stable and require less attention by technicians. The question of color for telemedicine use is to be approached with considerable caution.

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* Development of new equipment, such as the matrix camera, may correct this.

** National Television System Committee

*** Sequential Couleur A Memoire (France)
Phase Alternation Line (other European countries)

Color television requires greater initial outlays of money, mandates greater maintenance expense, and has not shown sufficient additional utility to justify the difficulties and expense. The "Interact" system in New Hampshire and Vermont uses color in dermatology, and plans to find definitive answers to questions such as: Are there lesions which can be diagnosed with color and not with black and white? How much time is spent in diagnosis using the two modes? Is reliability of diagnosis strengthened by using color?

Studies in the use of black and white television for dermatologic diagnosis (see Chapter V, Dermatology), have indicated a capability satisfactory to observers at Massachusetts General Hospital. Color is not the only important factor in diagnosis. History, morphology, location, and distribution are equally important, but when color is in question, a professional person in attendance with the patient must supply color information to the distant physician.

Bird has noted[5] that in many instances, adequate report of color, as in differentials on bloods prepared for televised microscopy with Wright's Stain, can be obtained from the distant lab technician. In a test, Robert Scully of Massachusetts General Hospital examined a hundred slides including routine surgical specimens, stained blood smears, and white counts projected from a remote location. He was able to identify all of them correctly using black-and-white television, only occasionally asking color information of the distant technician who was viewing the slides directly.

- Switching. Output from two or more cameras and/or two or more microphones can be selectively presented and instantaneously changed from one to another. This can provide efficiency in the telemedicine setting, where cameras are focused on different views, such as separate parts of the patient's body; by means of switching the information they transmit can be compared rapidly.

- Effects. A wide variety of "effects" which usually combine the output of two or more cameras on a single monitor screen is available for applications requiring "side-by-side" comparison in real time, or in instances where it is desirable to enter additional data on the screen for ready reference. One simple use of this capability might be the electronic insertion of the patient's name at the bottom of the screen, to aid the physician's memory.

- Lighting. Television camera tubes do not respond as do human eyes to light, therefore lighting is of critical importance if pictures are to give useful information.* An extraordinarily wide range of different visual impressions of subjects can be achieved by alteration of illumination. There are several variables which interact to produce the ways in which light affects what the camera sees: distance of light from subject; direction at which light strikes subject, relative to the direction from which the camera is "seeing" subject; intensity of source of the light; relationship of all the foregoing as from one light source to and among all light sources, in order to achieve lighting balance for any given situation.

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* Simplistically, the human eye responds to fewer quanta (wave/energy packets) of light than the standard TV camera does, and thus can function at lower light levels and discriminate among more subtle variations of light intensities.

There is no such thing as "standard" lighting; each interactive location must be carefully analyzed by users and technicians to determine functional lighting requirements.

- Low Light Level Applications. Where it is necessary to transmit visual information from an environment where light levels are as low or lower than "normal" room lighting, camera tubes are available both in black-and-white and color which are sensitive to light of low intensity (min. 1-2 footcandles, black-and-white; min. 6-8 footcandles, color.)

- Sound. Auditory information is relayed simultaneously with visual information. The range of frequencies transmitted, and their fidelity to the original sounds, are functions of the total system, from microphone through transmission and reception, to speakers.*

  The sound transmission of television can be designed so as to report auditory information in a wide variety of ways. Naturalistic sound (e.g., voice) can be selectively attended and transmitted, screening out or inhibiting transmission of extraneous, ambient sound. One can select a directional microphone in order to concentrate on the source of the sound and minimize sounds from other sources.** Sounds can be transmitted via electronic stethoscope with fidelity superior to the acoustic stethoscope. However, it may be necessary to degrade electronic stethoscope output to a level (100-1500 cycles per second) most physicians find comfortable, unless they choose to learn how to interpret sounds produced by heart, lung, and bowel at a wider frequency range.[7]

2. Psychological Properties of Television Communication

- The Tension Produced by The Frame. Everything is seen within and bound by the frame. This gives rise to tension at the edge of the frame, because the viewer knows*** that what is beyond the edge of the frame is continuous with what is in the frame. Therefore, the environment of television includes that which is outside the frame, and interaction with what is outside the frame is part of the total interaction taking place.

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* The different ways in which visual and auditory information are processed in the brain require a higher order of fidelity to the original in sound than in picture information. Once past a certain point of distortion of sound there is no way for the brain to synthesize the intent of the sound information. Information presented to the eye, however, can be checked and assessed for content so that a picture of far less than optimum quality will yield substantial amounts of information.

** A unidirectional microphone of the cardioid format is best for most applications. Where high fidelity is required this should be a condenser microphone, otherwise a good dynamic microphone will do. For a discussion of microphone formats, types, placements and recommended use written in lay language by a professional engineer, see The Access Workbook.[6]

*** This knowledge is, most of the time, outside conscious awareness. It comes into awareness, however, in situations such as those described below.

Frame tension is constantly utilized by producers of film and television melodrama. The audience knows what the heroine does not—that her life is in danger. She walks into a darkened room. Is the killer there? How and when will he strike? Where will he come from? The camera pans away from the heroine, around the room, hesitates at an open window, and pans back to the poor soul. The window is out of our view—out of the frame. The woman walks in the direction of the window, is silhouetted against it, and then, from one side of the frame, a man appears in the foreground, his back to us.

The same scene on the stage requires very different techniques. We may have seen the killer slip into a closet, upstage, and close the door. Here, we know where the danger will come from and probably how it will come. Tension is produced only by the factor of when. The filmic frame makes for tensions of where, when, and how.

Frame tension is frequently used in filmic presentations of comedy; also, to create suspense, surprise, and to differentiate among reactions.

Frame tension is always present whether the images or devised or spontaneous. Imagine the viewer's reaction if, during a football game, the camera following a ball carrier with one tackler between him and the goal line suddenly stopped focusing on the runner.

Those who were watching television at the time Lee Harvey Oswald was shot may recall anxiety or frustration produced by frame tension as the cameraman was unable to move to a position to get a clear picture of what was happening.

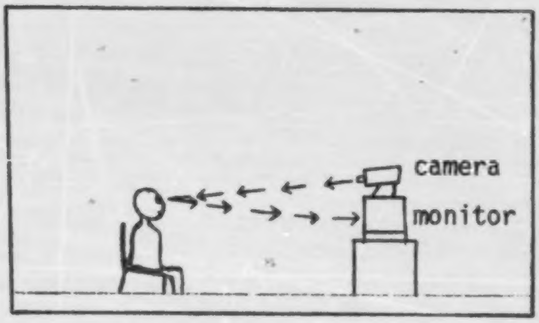
The point can be re-stated: what is going on outside the frame is part of the filmic space. Frame tension has always been an important factor in the filmic technologies, but rarely identified as such, even when utilized. It is a factor those who use interactive television must be aware of and with which they must deal.

Frame tension seems to mandate the possibility of eye-to-eye contact in televised interaction, particularly when the number of interactors is small, as in physician and patient interactions. Not only does the opportunity to maintain or break eye contact minimize the problems that may arise from frame tension, it emphasizes the physician's concern with the patient and concentration on the patient's problems. It sustains the focus of the interaction.

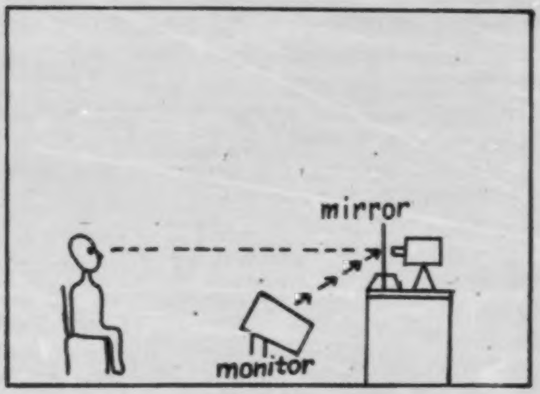
We do not consistently gaze into each other's eyes during face-to-face interaction. Typically the listener watches the speaker's eyes but the speaker looks away. "Most personal interaction is initiated by a short period during which two people look directly at one another. Direct eye contact is a signal that each has the other's attention and that some further form of interaction can follow ... In America, a typical pattern is for the listener to signal that he is paying attention by looking at the talker's mouth or eyes. Since direct eye contact is often too intimate, the walker may let his eyes wander elsewhere." [8]

The advent of televised interaction raises questions about the extent to which conventional face-to-face behavior is acceptable or appropriate in the new medium. There is some evidence, detailed below, that when the person with whom one is interacting gazes away, one's reaction is to interpret this as attention to something or someone unseen. On the other hand Dickson and Bowers, discussing behavior during interactions via video telephones, observe that, "When conversing on a video telephone and looking at the video display screen, both correspondents will tend to think that they are being looked in the eye for abnormally long periods of time. This abnormal eye contact probably increases tension during the conversation."[9] People who had used the videotelephone for as much as five years, however, tended to conduct interactions almost as if the instrument's video capability was unimportant. Two men who worked in a laboratory where video telephones were being developed and in experimental use were observed: One "was very blasé and only infrequently glanced at his display ... left the device aimed vaguely in his direction, and usually only his profile was seen ..." The other "often initiated or received his calls standing up ... Occasionally he looked obliquely at the display of his correspondent's face, who in turn saw only this man's torso. Perhaps these more experienced users are unconsciously avoiding the unpleasant sensation of excessive eye contact." The authors suggest that, if this sort of behavior becomes commonplace after a period of use, "it is difficult to see how it can be argued that [video telephones] enhance communication by allowing reception of the full range of non-verbal cues."[9]

Telemedicine transactions have not produced such extreme avoidance of eye contact. Physicians and other professionals need to establish rapport with patients and co-workers and to have nonverbal feedback. Ironically, however, achievement of precise eye-to-eye contact is not possible in current transactions using broadband television. The monitor at which one looks to see the other interactor is either above, below, or to one side of the camera transmitting one's image.



In the illustration, the subject will be seen by the distant observer to be looking down. The situation can be remedied slightly by positioning the camera well behind the monitor, thus narrowing the angle of the parallax. A better solution is to project the monitor image onto a one-way mirror directly in front of the camera.



Similar lens-line mirror arrangements already are used in television news broadcasting and with prompting devices. The monitor picture is electronically reversed, so as to read correctly on the mirror.*

- Motion Perceptions. Information relayed from a camera in motion is experienced quite differently from information relayed from a camera which is stationary. It may be required that the camera be fixed or moving in order for one to see what one wants to see. It is important, with regard to a moving camera, to analyze movement in terms of who is causing the camera to move: the distant interactor? The person on whom the moving camera is focused? A third person? To what purpose?

- Editing. (Interpretation) Editing or cutting was regarded by Eisenstein as the single most important factor in filmic art, because it makes possible interpretation of the material.[10] Ordinarily, editing means interrupting information from one picture source by information from another picture source, thereby guiding the viewer to see what someone else wants him or her to see in an intentional sequence and pace. It can be accomplished skillfully or crudely, causing either understanding or confusion. It can order material in a logical way or be a source of illogical disorientation. In televised interaction, however, where one frequently has control of the distant camera(s), there are many occasions when switching from one camera to another (editing) is useful, in order to make comparisons for one's own purposes as well as to illustrate or explain to others.

3. Some Cultural Issues in Interactive Television

- Proxemics. Edward Hall has discussed proxemics[11] in terms of spatial experience, or the distances we maintain in interpersonal relationships. Man exhibits territorial behavior, not just in his home, office, or other places where he has clear and simple rights of "ownership." Man carries his territory with him wherever he goes, and understands its limits very precisely, even though most limits are outside awareness in the sense that he can readily analyze them.

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* The mirror reduces light level to the camera by one-half an f-stop.

Because these limits are an essential part of culture, misunderstanding their significance can cause mild to extreme discomfort. *

Within the American middle-class northern European culture, Hall defines four generally accepted distances: Intimate, "close phase"—the distance of love-making and wrestling, comforting and protecting, where vision is acutely distorted and little-used; vocalization plays a very minor role in communication.

Intimate, "far phase" (six to eighteen inches)—vision is still distorted and communication is carried on in whispers or very low voices. This is the distance often violated by members of other cultures, who will speak in a much louder voice, breathe in one's face, and cause the eyes to cross.

Personal, "close phase" (eighteen inches to two and a half feet). At this distance one can be reached, or attacked. It is a distance we reserve for people we trust. People who are inside this distance ordinarily have a close relationship.

Personal, "far phase" (two and a half to four feet) is the distance just outside the limit of physical domination, where we keep someone else "at arm's length." It is the distance at which we can discuss subjects of personal interest and involvement without fear.

Social, "close phase" (four to seven feet). We conduct impersonal business at this distance, as with business associates. It is also the distance for domineering, as when standing and addressing another who is seated.

Social, "far phase" (seven to twelve feet). Business and social interaction at this distance is formal. An important person will have a desk large enough to keep visitors toward the far end of social distance. Voice levels increase considerably from close to far phases of social distance. This is the distance at which people in the same room can cease to pay attention to each other, as in a shared office; spouses can go about their own business.

Public, "close phase" (twelve to twenty-five feet). This distance is well outside the circle of involvement, and is often maintained when walking along the street in order to avoid danger or enable defensive action. Interaction requires a fairly loud tone of voice, and it is noted that choice of words, grammar, phrasing of sentences shift at this distance from what is employed at nearer distances.

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* A well-known aspect of "cross-cultural shock" is the discomfort many Americans feel in the presence of members of "warmer" cultures, when these individuals press very close and touch one's arm, hand, even face, in what we think of as situations requiring greater spatial separation. Latin, Mediterranean, and African businessmen, diplomats, and ordinary citizens often are confused, dismayed, even offended by our tendency to back away, frown, and show other signs of "coldness" or downright hostility when they are simply behaving in ways natural to their cultures.

> Public, "far phase" (twenty-five feet or more). Very important persons are ordinarily not approached closer than thirty feet except by permission, extended or implied. To communicate, one must project not only the voice, but the personality, as in the case of actors and public spakers. Other people are regarded more as objects than as persons.

The subject of proxemics is enormously complex because it reflects all aspects of our perceptions of ourselves in relation to others. Only a few highlights are touched upon here, and the illustrations are relevant only to one culture among all the cultures in American society, to say nothing of the rest of the world's cultures.* Middle-class Americans of European extraction tend to think in language whose symbols are very different from the kinds of symbols which are meaningful to other cultures, react differently to sensory stimuli than others do, have different ways of using and relating to architectural space, are moved to tears and laughter differently, etc. All factors in culture interact with the perception of the self and thus the ways in which the self protects against, enjoys, and otherwise deals with other persons in proximal space.

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* Gaye Tuchman, analyzing the unwritten policies which govern the way news is filmed for and presented on U.S. television, finds them informed by rather particular sociocultural attitudes about the uses of space. Television news, in seeking to maintain "objectivity," prefers to maintain "the use of a camera placement similar to a person of average height confronting another person eye to eye. All else is condemned as 'distortion,' and the cameraman and reporter who jointly produce the affronting footage are liable to receive an official reprimand." Distance from a speaker, whether it is a person actually making a speech, someone being interviewed, or the newsperson him/herself, ranges from far personal distance to far social distance. To come closer than far personal distance is felt to conflict with "straight, hard, objective news," and the news camera would only go closer for "dramatic impact when someone with an 'interesting face' was expressing emotion." In specifying this latter "non-objective" reporting Ms. Tuchman elicited from a cameraman an example: "He gave (the example of) Rose Kennedy discussing her dead sons, suggesting he would come in on her face and try to capture a tear." She goes on to note, "The camera may not suggest that the TV newsmen have emotions or ideas about the story they are reporting, that the reporters get 'too close.'"

On the other hand, "Public distance is all but forbidden to record events involving 'individuals,' even though those events may normally be seen from a public distance. One might suppose that television news film could use 'public distance' to gain viewers the experience of having attended an event or speech. This is supposed to be objective, because theoretically, it would decrease the emotional involvement between viewer and speaker. However, public distance precludes the personal and social contact which are the hallmark of television news: public distance depersonalizes." Hence, by the definitions of TV newspeople, "the use of public distance is 'unnewslike.'"

Ms. Tuchman comments, "In sum, television news film of 'straight objective stories' incorporates Hall's notion that different social distances have different social meanings."[12]

What are the implications of proxemics in telemedicine interactions? Only trial and error will bring even preliminary answers, but one must be aware of the possibilities. Several questions should be raised:

At what apparent distance does the physician cease to be a friendly symbol of help and become over-domineering or even a threat? At what apparent distance does the physician seem to be authoritative? Merely cold? When the patient is aware of the apparent distance at which the physician sees him or her, how does he or she feel about it at an intimate distance or at public distance?Are there exigencies which legitimate disregard for patients' feelings in these matters? What can be learned about proxemic attitudes among members of cultures different from the telemedicine professionals' culture(s) so as to facilitate productive interaction?

- Differences From Face-To-Face Interaction (Codes of Behavior)*. In viewing telemedicine transactions and videotapes of both sides of transactions (to see and hear what the participants were seeing and hearing) one notes that some of the conditions which define face-to-face interaction obviously are not present. There can be no sharing of a common physical environment and there is no possibility of touching. The television frame puts out of sight some or all of the time, information that is ordinarily available at all times in face-to-face settings. On the assumption that humans have devised ingenious codes of behavior to deal with the intricacies of face-to-face settings, the possibility is suggested that difficulties may arise in televised interactions where use of seemingly appropriate face-to-face codes fails to take into consideration that face-to-face conditions do not obtain.

In ordinary face-to-face interaction, all who share a common culture understand the code very well. The code consists of legitimate ways to deal with a wide variety of contingencies. A code accounts for our reactions when a third person enters the room, when we look away from the person with whom we are talking, when we leave the room momentarily or at the end of a visit. We instinctively understand how codes differ between living room conversations and office encounters, and between friends, business associates, strangers, or with physicians in their offices, etc. Codes of face-to-face behavior are second nature to us and most of the time we are not even conscious of them.

When we move away from the face-to-face setting, it is necessary to devise or to develop codes for the new setting. Telephone interaction is a case in point. Methods for beginning and ending the conversation are unique to the medium. We constantly have to indicate our continued presence and attention to the other speaker. We do this by making small sounds, typically "Uh huh." All of us have had the experience of talking with someone who does not realize the necessity for making the small sounds which certify his or her presence and attention. We come to the end of a thought and experience a long pause, followed by our asking, "Are you still there?"

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* In this section, we draw on informal discussions with Erving Goffman, during and after viewing with him videotapes of telemedicine transactions, as well as from his published work.

Our vocal pattern on the telephone tends to be more careful than in face-to-face interaction because it is the voice alone which is communicating. Speech must be more distinct and intonations and inflections must convey what we might otherwise communicate by gesture. Many people are not as adept with telephone codes as they are with codes of face-to-face interaction.

In the interactive television medium, we are confronted with a situation wherein we have little experience as to what codes are useful or appropriate, so that improvisation and modification are the rule. As televised interaction comes into more general use, we will attempt to develop the necessary comfortable codes for interaction. However, Allen Shinn* points out that codes of behavior in the telephone medium have not evolved— after nearly a century— to the point where communication capacity is always utilized either fully or well. Study of code negotiation in interactive television may help to alleviate communication problems in the newer, far more complex medium.

People with some experience in telemedicine interaction may take exception to this stressing the need for development of new codes of interaction for use with two-way television. One of the observations most consistently expressed by people newly-initiated to telemedicine is that, "It's just like talking to someone face-to-face." This observation says a great deal in favor of the validity of televised interaction. People accept it; they can get the job done via television and in most cases it has saved them travel time and possibly, time during the transaction itself. **

But, televised interaction is not the same as face-to-face interaction. To ignore fundamental differences is to reject the opportunity to optimize them or to fail to recognize their potential pitfalls. Every interactive medium possesses several specific features, a few of which are:

- Its evidential boundaries. In a room there are doors. What are the functional equivalents for doors in a telemedicine interaction?
- The distances between participants. Face-to-face distances are mutually confirmed by the evidence of sight and sound. In a televised interaction the "evidences" of sight and sound may be in total conflict with each other. For example, when the microphone is several feet away from the speaker and we see the speaker in full-face close-up, picture reports "closeness" and sound reports "distance." The feeling of apparent distance is further compounded by the distance between the television monitor and the person looking at it.

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* "The telephone has been in widespread use for nearly a century, but there are still substantial numbers of people who have not sufficient experience with it to use it easily and freely. Almost certainly we still do not use it to the fullest capacity. Conference calls, for instance, often seem to be awkwardly handled and less productive than they should be, perhaps largely because few people seem to have figured out just how to conduct them. It appears that we could speed up the process of development of a code of operation for television considerably if we went about it self-consciously, and thereby save ourselves a long period in which we would otherwise use TV systems less effectively than necessary." 14

** See below, Reference 15.

- Its off and on contingencies. In face-to-face interaction we have many legitimate ways of transferring attention from one person to another, of going off into a "brown study" of being distracted. Already we have evidence that in television interaction such behavior cannot be adapted directly from face-to-face codes.* Will the interactive television medium mandate that we severly limit the number of off-on contingencies?

- Arrangements for initiating and terminating the interaction. Will these arrangements have to be more conventionalized than for face-to-face interaction, as they are in telephone interaction?

- Its facilitation of both assessment and communication. Face-to-face interaction clearly has greater assessment and communication capability than telephone interaction. The extent to which two-way television interaction has capability for greater or less communication, greater or less assessment, than face-to-face interaction is not clear, although some discrete aspects of assessment have been reported.**

- Its potential for manipulation of one person or persons by another. One case of manipulation could be the creation of an asymmetrical situation wherein a certain person or persons in a transaction assume rights and privileges, and thus power. In the commanding officer's or boss' office, subordinates are required to maintain a formal bearing until invited to be at ease or to sit.

The face-to-face relationship between physician and patient is extremely asymmetrical in order that the physician maintain efficiency and control of the situation. The patient waits at the doctor's convenience; the patient does what he is told, in the sequence he is told to do it; the physician asks questions of the patient, he does not expect questions in return until he asks for them; the physician touches the patient, he does not expect to be touched in return. In the telemedicine setting, the situation may be restored to greater symmetry because the environment, though shared, consists of two spaces. The patient may respond to this greater symmetry in very positive ways, such as by showing greater candor, being more relaxed, etc.

It is possible that the effort required to maintain the asymmetrical situation is something the physician will find he is well rid of in the telemedicine setting. He is no longer required to be on guard during the frequent invasions of intimate and personal space that he must initiate when face-to-face. A major reason for the asymmetrical situation in the doctor's office is the requirement that none of his time be wasted. In a telemedicine setting, Irving Bush[15] notes that the physician never has to see a patient until the precise moment when the patient is ready to be seen. A resident or nurse has done a thorough work-up on the patient. The physician doesn't have to wait for the patient to come into the room, be seated, or be prepared in varying states of undress. Furthermore, the television transaction, possibly for reasons of focus and intensity, is shorter and when it is finished, the physician can turn off his set and get back to work at his desk, until the next patient is ready to be seen.

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* See "Observed Phenomena" below.

** See Chapter V, Studies of Assessment Capability and Acceptance.

Eliot Freidson,[16] commenting on both the lack of codes of behavior and observations concerning symmetry in the telemedicine setting, notes that for "ordinary people interacting through television ... it is important that such codes be developed if the potential of telemedicine is to be realized. Consider the fact that the medical personnel who will be using telemedicine will be using it fairly frequently and will begin to develop their own code of face-to-face behavior. However, the patients who will be using the system, unless they are specially selected, will have only fleeting or episodic contact with this medium. In this sense, the personnel will be able to develop a code and be comfortable, while the patient is much less likely to develop one on his own unless he has had some special and unusual experience. In this sense, while there is a certain degree of symmetry in the relationship on television, there is asymmetry in familiarity with the medium itself and ability to be comfortable with it and manage oneself socially on it. Such a handicap for the patient is a problem which should be faced. Perhaps one can, by examining the behavior of newsmen on television, and the behavior of people on talk-shows, work out the fundamentals of a code of face-to-face behavior, and prepare a little card or pamphlet describing the highlights of how one manages oneself [in television interaction], so that they [patients] will not be handicapped by the strangeness of the situation."

Freidson goes on to note an apparent contradiction. "It seems to me that you are implying that the telemedicine setting is no less asymmetrical than the office setting, the difference being that the physician himself does not have to work at maintaining such asymmetry. It can all be done before he even arrives in front of the television camera, so that he can save time and worry. I am sure that you are as familiar as a layman like me with the phrase 'prepping,' which refers to the activities performed by non-physicians to prepare a patient for surgery. In essence, it seems to me that telemedicine makes it possible for everything to be 'prepped' in advance so the doctor can simply move in like a surgeon and do purely functional work. I'm not sure I would argue that there is greater symmetry between doctor and patient under the circumstances. Interaction is restricted, unless some new requirement for an elaborate etiquette were introduced. If I am right, this is indeed a selling point to doctors, particularly the super-specialists who like to make use of every minute to perform their esoteric functions, but I am not exactly sure that this is the best thing in the world for humane patient care."

One additional note here is that observations about symmetry seem closely bound to matters of territoriality and the perception that territories are differently limited in the dual-space interaction. *

- Class and Culture. Taking into account what has been noted in the discussion of proxemics and the discussions of differences from face-to-face interaction and symmetry/asymmetry some cautions may be high-lighted in cases dealing with class and culture. Since cultural and ethnic differences can often make for difficulties in the face-to-face interactions between physicians and patients,

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* We will return to the discussion of symmetry/asymmetry following examples of behavior observed in telemedicine transactions.

what are the ways in which televised interaction may ameliorate or exacerbate those difficulties? Does the interactive medium have potential for creating different difficulties? Will people from "disadvantaged" socioeconomic groups, who are often extremely deferential in face-to-face contacts with physicians, emerge in the possibly more symmetric telemedicine setting as less deferential, more candid and outspoken? If they do, will this result in problems or opportunities in providing care? This is not meant to imply that telemedicine will find either its worst problems or greatest opportunities in dealing with patients from classes or cultures different from those of the majority of today's physicians.

- Perception and Meaning. People attach differing meanings to what they perceive. Perception is more or less acute, according to the degree of meaning attached to an object or an idea. Meaning is often culturally derived. Many Orientals think Caucasians look alike. Caucasians looking at Oriental ideographs see them as abstract art rather than as language symbols.

Members of a culture perceive what is of special interest to them to be full of meaning that is ill-perceived by non-members. When meaning is many-sided and complex to one person, that individual's senses are geared to select and discriminate among varied data which are incomprehensible to another person who is not a member of the first one's culture.

R. L. Gregory[17] notes the undeniable role of experiential learning that is implicit in perception. Harking back to a previous account of a man blind from birth who regained sight in his fifties, Gregory states, "The blind man S. B. ... never learned to interpret facial expressions; they meant nothing to him, though he could read a mood from the sound of a voice. Hunters can recognize birds in flight at incredible distances by the way they fly; they have learned to use small differences to identify objects which look the same to other people. We find the same with doctors diagnosing X-rays or microscope slides for signs of abnormality."

It is useful to think of physicians, in their professional roles, as members of a common subculture which sets them apart from the main culture they share with non-physicians. Certain attitudes, meanings and perceptions are "second nature" to members of the physician subculture and the more institutionalized these attitudes, meanings and perceptions become the less they are subject to conscious analysis by physicians. Yet it is precisely at the level of what is "second nature" that we must seek to find how physicians go about looking for meanings.

What is the physician looking for when he examines the oral cavity? Where does he look, and what is the sequence in which he looks? What does he do with the instruments he uses and why? What does he mean by something being "in the way" of what he wants to see, and what is not "in the way?" He may have done an oral exam so often that it is quite difficult for him to answer such questions.*

Careful studies are needed of the ways in which physicians look for signs and elicit information, if we are to determine how best to maximize the capabilities of the interactive medium at the human-technology interface.

Since most of the equipment used in telemedicine was designed for uni-directional television, it may not be optimally responsive either to the physician's particular perception-meaning requirements nor to the instant flexibility required for expedient, productive interaction. However, equipment can be designed to obviate the delays and failures that can occur when a physician discovers he cannot easily see or hear what he wants in the way he needs to see or hear them.**

Observed Phenomena in Telemedicine Interaction ("Something Different Is Going On Here.")

A number of telemedicine field reports and observations have suggested that interactions between people on two-way television are indeed different from face-to-face interaction, and also are different in degree for each interaction. Thus, factors which create changes in televised interactions may well be influencing the effectiveness of the transactions, as well as outcomes, efficiency and utilization. One may further hypothesize that effectiveness, outcomes, efficiency, and utilization are influenced also by user attitudes toward telemedicine as a means of performing professional tasks which require interaction. Finally, it must be emphasized that while the matters dealt with in this section have not been subjected to systematic investigation, there is a growing awareness of need for such study among telemedicine's practitioners as they gain experience with the medium.

At the fourth conference of the seven contractors who were awarded funds for 1972-73 telemedicine experiments by HCTD Dean Seibert of Dartmouth summarized a general feeling: "We've come to realize that, for all the satisfaction and success we believe we've obtained from telemedicine, we really don't know very much about how it works best and how to get the most out of it. We need to have time to learn how to use the technology and adapt it to our needs— and probably to learn how to adapt ourselves to its requirements."

Anecdotal observations indicate this underlying awareness that "something different" goes on in interactive television:

1. Kenneth Bird[18] has noted that in both of the Massachusetts General links, patients, physicians and nurses may exhibit confusion, frustration, or resentment of varying degrees if an unseen person or persons are known or sensed to have become involved in the transaction at the distal space. Adverse reaction is brought on by any interaction (whether or not involving speech) between the unseen intruder and the one "to whom I am talking," and tends to increase with the intensity of the distal interaction.

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* Have you ever tried to describe precisely, to a non-driver, exactly what you do when you engage the clutch in low gear, and what you do differently when going from first to second gear? A physician may perform dozens of functions which are far more complex.

** Approaches to this problem are discussed in Chapter VI.

2. A physician at Dartmouth Medical Center[19] became concerned as to "...how the patient is seeing me. Am I looking at her?" and was advised that in order for the patient to see her face-on, she must look up at the camera lens. Inasmuch as the physician's own view of the patient was from a monitor off to her right, she was forced to "sneak" looks at this monitor for visual confirmation of the patient's condition while simultaneously attempting to maintain the appearance of a straightforward conversation with the patient.

3. Irving Bush at Cook County Hospital in Chicago,[20] assessing a number of two-way interactions (via Picturephone) in which patients' explicit sexual behavior was the central matter, observes that patients' candor and comfort in coming quickly to the point and revealing intimate details often exceed what he experiences with patients in face-to-face situations.

4. Charlotte Sanborn notes[21] a relaxation of attitudes about privacy and intimate personal exposure in the interactive transactions between Dartmouth and Claremont. Some transactions include only a psychiatrist and the distant patient. However, the patient's primary-care physician sees and hears both ends of the transaction via two monitors. The primary-care physician's observation is known to both the patient and the psychiatrist. Also, it is known that the primary-care physician will discuss the patient's case with the psychiatrist after the transaction is over. A woman who came in for a gynecologic exam accepted a nurse's presence with her in the examination room and the gynecologist's presence via television. She objected to other physicians being in the examination room with her, but was aware that they were observing her over the television in the adjoining room.

5. A schizophrenic patient at Bedford Veterans Administration Hospital was not willing to accept any interview with a psychiatrist. Bird and Dwyer[22] reasoned that this might be connected with the patient's fear of being trapped in the doctor's office. Consequently, they arranged for an interview via the telemedicine link from Bedford to Massachusetts General. The patient was brought up to the telemedicine room at Bedford and was shown the psychiatrist on the monitor at an apparent distance of 12 to 15 feet. The patient still refused to have anything to do with the psychiatrist. However, when the remote control of the camera on the psychiatrist was adjusted to make it appear that the psychiatrist was in the neighborhood of 20 feet away, the patient's reserve diminished sufficiently that he was able to respond to the psychiatrist. They proceeded to talk. In the course of the ensuing interaction, the patient inadvertently touched the remote control unit and caused the zoom lens on the camera facing the doctor to "move in." This caused the psychiatrist to appear to come much closer to the patient. The schizophrenic recoiled and shouted, "Get back, get back!" The nurse in attendance with the patient moved the camera control to its former position, and after a moment, the interaction resumed.

6. Thomas F. Dwyer, reporting on psychiatric interviewing and treatment conducted between Massachusetts General and Bedford, has said,[23] "The patients from the start were less prejudiced than I. It seems probable that in some instances the patients were more comfortable talking to a psychiatrist by this means than meeting him in an office or clinic, a matter worth investigating since it bears on reaching a wider population and starting treatment earlier." In a report of the Massachusetts General experience[24] the point is made even more forcefully:

"The physician-patient psychiatric exchange via interactive television appears to be more comfortable for the patient than the usual face-to-face confrontation."

7. While screening a videotape of a telemedicine transaction, it was noted that one of the consulting physicians suddenly dropped his gaze to look at something. One's reaction was instant. "What's he doing that for? What's he looking at?" I can't see what he's looking at." Although patients have not been reported as making comments of this nature, it may be that momentary dealings with matters outside the frame will raise these kinds of questions, albeit out of the conscious awareness of most people.

8. Thomas Willemain reports a personal experience[25] which serves to illustrate how fundamentally technology works to mediate interaction, simply by failing to function in the expected manner. As a patient himself, Willemain went to one of the Cambridge Hospital clinics. After an initial work-up by the nurse practitioner present, he was requested by the nurse to undergo examination via the telemedicine link. The nurse called a physician whom Willemain knew at Cambridge Hospital, who after a few minutes appeared on the screen. The physician was unable to operate the equipment so as to produce sound from either end. He finally decided to conduct the transaction on the telephone with the nurse, at the same time letting the television picture proceed. Willemain was confronted with a situation in which he could see the physician but could hear only the nurse's end of the conversation. When she described certain symptoms Willemain could observe that the physician frowned, shook his head, nodded gravely, etc. but he had no other clue as to the physician's reaction. Willemain says he found the experience somewhat unsettling and that it would have been more so had he not known the physician.

9. In screening a number of videotapes of telemedicine transactions, the writer has been struck by a behavioral change on the part of many physicians when they are suddenly caught unawares and realize they are "on camera." This happens when there are two or more physicians in the space, when the camera is moving, and where all participants are not seen all the time. The physician will quickly straighten up and adopt an attitude of concern and seriousness in contrast to the more relaxed, even jocular attitude that he or she was seen to be displaying in the brief unguarded previous moment. The physician must perceive himself or herself as playing a different role when "on camera." The shift from being "off-camera" to being "on-camera" is also a shift from an ordinary face-to-face interaction to an interaction that is mediated by the technology. Being forced to change roles is not necessarily troubling to the person who is momentarily "caught." We are all adept at swift changes in role. (One recalls the presence of mind attributed, probably apocryphally, to Noah Webster, when interrupted by his wife while he was dallying with the chambermaid. Mrs. Webster gasped, "Mr. Webster, I am surprised at you!" To which Mr. Webster is said to have replied, "No, Madam. You are astonished; I am surprised.")

10. Principals in the Mount Sinai-Wagner Clinic Project report[26]
"1. When the nurse at the clinic is communicating with a health provider at the Medical Center, we discovered it is important that the relative sizes of the images be the same. Otherwise there is the feeling on the part of the nurses of a large authoritative image talking down to a small subservient image, (a feeling

that is enhanced by the height of the television receiver at the clinic.) This problem arose particularly with the use of the zoom lens at the clinic where the lens was adjusted for a distance (75 mm) and the image of the nurse would occupy perhaps 1/4 of the screen, while the lens at the Medical Center (25 mm) provided an image which took up most of the screen.

It was important for the clinic personnel to learn to adjust the zoom lens to provide approximately equal image sizes. Once this was called to our attention, it was relatively easy to correct."

"2. Although the relationship between Dr. Cunningham and Ms. Thomstad is an excellent one, the initial reaction to teleconsults between these two individuals tended to invoke an image of 'The Face of God' or that of a highly authoritarian figure dispensing expertise. This situation does not exist when they consult in person. As Ms. Thomstad put it, 'When I looked at him, I thought he looked more impressive, more authoritative. It reminded me of the beginning of a nurse-doctor relationship ... you can no longer remain passive in front of the camera, but must talk to the 'expert'.' Over time this problem became minimal. However, when new nurses come on staff, there must be an awareness on the part of the Co-Directors of this potential problem."

11. J.S. Gravenstein and his colleagues[27] report an incident that took place in an operating room of the V.A. hospital at the other end of the link with the Case Western Reserve Medical Center just prior to the initiation of transactions. "When the system was first tested, it had not yet been explained to the O.R. supervisor who, by chance, entered the empty operating room. When the technician saw her on his screen in the remote control room, he tracked her through the room. The nurse noticed it, tried evasive maneuvers, did not succeed and finally burst in tears rushing to the wall and pulling all electrical plugs to stop the monster who was following her every step. We had a major complaint on our hands and ... much explanation and apology was necessary to restart the system."

Observed Phenomena Reviewed

If we reflect on these illustrative anecdotes, they seem to be related to some of the matters previously discussed under "Psychological Properties" and "Cultural Issues" (Frame Tension; Proxemics; Codes of Behavior; Assessment and Communication; Symmetry; Perception and Meaning.)

Numbers in parentheses correspond to the numbers of the anecdotes immediately above.

(1) Interaction with persons outside the frame invokes frame tension and illustrates the need for a code that takes this into account.

(2) There are implications that problems of maintaining eye contact conflicted with the physician's "second nature" patterns of perceiving meaningful data. Probably she intuited that her failure to make eye contact might be interpreted negatively and that the interaction had become unreasonably asymmetrical.

(3) What causes this much-noted relaxation in discussing private matters? We should test the hypothesis that one perceives that the territory of the self is in less danger and does not need the kinds of defenses one erects in face-to-face settings.

(4) Same comments as (3).

(5) What were the schizophrenic's perceptions of his use of space and the distances that defined intrusion of others into his space? It would seem that for the psychiatrist, the patient's boundary equivalent to the far phase of personal space was more than 15 feet!

(6) Same comment as (3).

(7) Although the physician's attention was not being given to another person, it was being directed to something out of the frame unseen by the distant participant, so one would consider this as similar to the problem in (1).

(8) Obviously the physician who was having difficulty operating the equipment needed better training in its use, but the incident also made the situation a very asymmetrical one for the patient. There are implications about potential manipulation of the patient which could raise ethical questions about use of the medium.

(9) To what degree is the televised transaction adversely affected when participants are made aware that the distant interactors are playing special roles for them?

(10) These evocations of authoritarianism seem clear examples of one aspect of proxemics perceptions.

(11) The situation involving the nurse and the tracking technician illustrates the degree to which asymmetry can become manipulation very rapidly. For the nurse, the situation was utterly asymmetrical. The medium became an adversary as her territory of self was violated in a manner that she perceived at first to be out of her control.

Symmetry: Some Preliminary Inferences

Problems and opportunities that are chiefly related to the symmetry issue would appear to yield more readily to correction or optimization than will those related to proxemics, meaning/perception, and other cultural and psychological areas of investigation. This may be simply because situations clearly related to symmetry are more obvious, because symmetry often is involved with frame tension and its apparent mandate to maintain eye contact, or because ordinary doctor-patient relationships— no matter what the differences or similarities in the individuals' cultures— seem to carry a degree of asymmetry in face-to-face interaction not readily duplicated or legitimated in televised interaction.

Symmetry: The Positive Side

Symmetry seems to promote an atmosphere in which patients can discuss functional disorders with candor. This also means that patients will quickly "get to the point" when discussing anxiety, fears and forebodings. If telemedicine provides a relaxed and non-threatening setting, perhaps physicians can get to the bottom of the emotional component more readily with some patients than they do in face-to-face confrontation.

Symmetry: The Negative Side, Some Dangers

Going to the other side of the symmetry question, one notes that the problems of symmetry described above tend, in greater or lesser degree, to create discomfort and damage or hinder the interaction and presumably render it less effective.

Possibly some problems arising out of the symmetry/frame tension nexus can be controlled before a code of behavior for interactive television has been refined by awareness and experiential trial. Furthermore, most patients and medical sociologists have observed behaviors on the part of physicians which may appear to be accepted in the asymmetrical face-to-face medium but will probably be unacceptable if situations of greater symmetry become the norm in interactive television.

The writer has observed the following during a telemedicine transaction: Two physicians are jointly examining a patient. They arrive at a point where they feel they no longer need to converse with or look at the patient, and turn to talking with each other. They do not excuse themselves. They simply turn abruptly away. During the course of their conversation the image on monitor screens is an extreme close-up of the patient's face. Although the physicians are behaving as if the patient weren't there, the patient is very much there and growing painfully aware of enforced and awkward presence.

Eliot Freidson[28] comments, "What you referred to with some shock is something that occurs routinely on hospital floors while physicians are making rounds. After examining the patient, they stand around talking about the patient as if the patient were not there. It is the absence of a television camera which prevents the recording of the distress on the patient's face. This, then, is nothing new, and the use of television could very well spread this characteristic outside of hospital walls."

Conversely, one could also assume that television interaction, in exposing this particular behavior, will demonstrate to physicians its effects upon patients and therefore foster change. It may be that simple and graceful ways can be developed to legitimate temporary leave-taking, analogous to briefly leaving the room in a face-to-face interaction. If participants, patients and professionals alike, are provided with an additional monitor on which to see themselves, perhaps it can be used as a "mirror;" if a participant also has remote control of the proximal camera, then adjustments can be made either to move oneself, during the interaction, to a comfortable distance or out of frame, entirely. Consideration may be given to allowing participants to shut off the cameras trained on them, an equivalent to hanging up the telephone or leaving the room.

A problem seems to arise in interactive television when physicians use forms of address which many of them are accustomed to using in the less symmetrical face-to-face medium. Physicians often will turn to the nurse and refer to a patient simply as "he" or "she" while in the patient's presence. In the asymmetrical face-to-face medium it may be legitimate to use these forms of address which most of us would deem discourteous in almost any other social medium. If the interactive television medium is supposedly more symmetrical this third-person usage is questionable, yet it is frequently seen. In order to provide a ready reminder for the physician, the patient's name could be displayed along the bottom of the monitor screen on which the patient is being viewed.

Effects of the Telemedicine Medium on Physicians' Attitudes Toward It.

By and large, telemedicine practitioners report that satisfaction with the medium outweighs dissatisfaction both for professionals and clients. Social science observers warn, however, that many of these positive attitudes may be due to the strong novelty effect. The physicians most deeply involved in telemedicine perhaps regard themselves as pioneers, and are often very enthusiastic and stimulated by the experience. Patients also may be aware that they are involved in something new and exciting, and may indeed receive more attention from the physician than in face-to-face settings.

People in charge of telemedicine projects have noted that there is a small group of users who account for the bulk of interactions. Whereas it is true that physicians who have been responsible for promoting the telemedicine facility in their setting, and/or involved in its planning and implementation phases, are members of this group, there are usually a few others who seem to take to the idea, also. Nevertheless, the largest amount of telemedicine utilizations tend to stabilize among a relatively small number of professionals. Jon Wempner[29] remarked that, "Physicians are the only people in the community with this thing. If others had it—when it gets as common as the telephone—then it will be thoroughly accepted." This implies not only the acceptance that accrues from general use of a technology, but also that wider utilization will develop a code of behavior to facilitate greater acceptance of its use.

Although some physicians who harbored skeptical or negative attitudes about telemedicine have become users and enthusiasts when given the opportunity to participate in interaction, nevertheless, televised patient care has many detractors among physicians. Bird and his colleagues[30] candidly discussed resistance to the changes implicit in telemedicine in their own experience and related it to other examples of resistance to change in the field of medicine, generally. They illustrated their point with this quotation from Machiavelli: "It must be considered that there is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new order of things." Unlike what occurs in the more open atmosphere of a teaching hospital where colleagues are able to share experiences and sometimes challenge specifics of practice, physicians at the distant Bedford V.A. Hospital were in effect practicing "in a degree of isolation comparable to the general practitioner in a remote community with no colleagues available to him ... if a psychiatric consultant was called in (and for some of the physicians this was rare), the consultant's advice often reached only the requesting physician and not the ward team. "Also, adverse experiences with television consultation had at first, "influenced a group of physicians at the Bedford Veterans Administration Hospital to avoid use of the Teleconsultation system."

Difficulties based on reluctance of professional staff to "expose" themselves were anticipated. Bird et al quote from Ishiyama and Grover,[31] who noted that "when an important change is introduced into any hospital ... two paradoxical effects may result ... The threat to security was seen as being inherent in the new project. If the demonstration project could accomplish one of its goals, i.e., the provision of better treatment with consequent increase in the number of improved patients, this might be taken as an indication of the personal inadequacies of many of the staff members" and "The fear that the project might be too successful was mixed with envy. The possibility that someone else might enjoy the fruits of success while they were faced with the realization of inadequacy became the basis for depreciation of the threatening project. The feeling of being left out was then one of the underlying factors in the expression of anxiety and hostility. The nature of the seed bed effects the transplant."

Some of the preparations made for the Massachusetts General-Bedford V.A. Hospital link were described by Bird et al:[30] "Attitudes, actions, and comments in our early and planning stages were carefully evaluated [so that] before teleconsultation activities began, a number of steps were taken to lessen anxiety and promote the concept of interactive television use as a means of exchanging patient-oriented health information and ideas. For some departments or services, where the idea of continuous teaching and learning was already accepted as an integral part of medical practice, the explanations and assurance offered were enough to allow a smooth incorporation of teleconsultation into the existing program."

Resistance to teleconsultation between Massachusetts General and Bedford has not yet totally disappeared though the concept now has scores of adherents. Perhaps real acceptance will happen only when interactive television is something in wide-spread, general use.*

In addition to the cited careful planning and innovations designed to make telemedicine more acceptable in the Massachusetts General-Bedford situation, many other things have been done there, including the preparation of videotapes for training and self-assessment, and introduction of other programs which utilize and expand the information and experience of professional participants.

Telemedicine is perhaps correctly viewed by many physicians as a threat because they are vulnerable to inspection by others, particularly consultants. Telemedicine becomes an unwanted form of peer review and conjures up whatever misgivings or anxieties physicians may have about admitting someone else into what is often perceived as a private preserve. Freidson[32] described the attitudes of many physicians in this regard: "The anatomy of his status and the individualism encouraged by the demands of his work make it difficult for the clinician to either submit to or participate in regulatory processes that attempt to assure high ethical and scientific standards of performance in the aggregate of practitioners. He wants to control the terms and content of his own work and is not inclined to want to lose that control to profession-wide, systematic auspices. In science and scholarship the obligation and necessity to publish keeps one's work public and under the scrutiny and evaluation of colleagues. But to the consulting practitioner, his work and its results are seen almost as a form of private property."

In a group practice, as in a teaching hospital setting, the physician's "ownership" of the patient is shared with colleagues, and this may lead to quite a different posture. A ready comparison of group vs. private rationale is referred to by Freidson[33] in a statement made by a generalist in group practice: "A doctor is kept on his toes and motivated by his sound sense of self-esteem, to be respected by his colleagues for his professional performance. A doctor is exposed more to scrutiny in a group setting, especially more than in his own private office. There, a doctor knows he could get away with murder. There is no one to pass judgment on what he does in his own office; no one reviews his records; no one ever judges the quality of his work. He may refer to specialists but it doesn't expose him to the scrutiny of his medical colleagues."

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* The point here, however, is that if telemedicine is to help in alleviating some of the problems faced right now in health care, initial resistance on the part of many physicians will have to be overcome prior to the emergence of "the wired nation."

A general apprehension about consultation is the purely economic one candidly expressed by many physicians, and stated in a specific context by a general practitioner in New Hampshire when discussing the opportunity presented by telemedicine to obtain psychiatric consultations: "You send a patient to a surgeon for consult and you get a note back; you send a patient to a psychiatrist and you don't even get the patient back."[34] There is also a potential loss of prestige or reputation in the medical community as a result of this consultation process. Freidson noted that group practice may alleviate these fears. He was told by a specialist,[35] "One good thing about the group is that there is no loss of face when you consult somebody in the same specialty, and it is perfectly all right anywhere for a medical man to consult someone in a specialty in general. But when you want to consult somebody in your own specialty in private practice, you lose both face and possibly money. In the group, one of the good things is that you don't. There is no fear of losing patients; there is no charge for consultation; there is no loss of prestige."

It is not within the scope of this report to examine pros and cons of practice modes. However, it would appear, at this stage of its development, that telemedicine may encounter less difficulties of acceptance in settings where professionals, either because of organizational design or their own desires to be less isolated and more in touch with peers, are prepared to participate openly and with less apprehension about the actions or judgments of others.

Relationship of Professional Users to Interactive Television Technology

Many previous medical applications of uni-directional television technology* came into being as solutions in search of problems on the assumption, apparently, that television could solve a wide range of problems, usually educational ones, involving both distance and time. When it was discovered that simply turning on cameras and microphones didn't take care of the problems, some concluded that "television can't do the job." Despite many successful applications of uni-directional television there are millions of dollars worth of television equipment lying unused in hospital closets to attest to this unfortunate misapprehension, mute evidence that television technology is poorly understood.

What relationship do physicians have to technology in general? They employ it to a greater degree than other professionals, not excepting most engineers. The non-specialist outgrew the "doctor's bag" by the end of World War II and today utilizes instruments, electronic gear, machines and diverse apparatus unknown a quarter to half-century ago. Specialists, who greatly outnumber non-specialists, require an array of hardware that staggers comprehension.

Principally, technology gives the physician information he cannot discover with his unaided senses, performs tasks his hands alone cannot accomplish, or produces or assesses data faster than he can. Technology enhances information,* prints it, shows it on a cathode ray tube, displays it against a calibrated scale, makes a photo of it, renders it audible and pipes it through a lens or fiberoptic bundle. It supplies fluids or gases, delivers discrete electrical charges, washes sera, and extracts tissue.

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* As opposed to the bi-directional technology used in telemedicine.

Physicians are justified in expecting the technology of interactive television to function in a manner consistent with what they expect of technology generally. It should enhance information, and should do so reliably. Like the interactive computer, it only requires technicians to provide a reliable, non-interfering conduit, and who are helpful in explaining its potentials and limitations to the physician.

One reason why physicians and others may feel that television technology is not their concern is that the "television people" with whom they are associated have been at some pains not to provide such a conduit. Rather, television associates often have been at some pains to build their own professional status on the twin rocks of exclusion and mystery: "Don't worry, we'll take care of all that. If you had a lot of time, I'd explain it, but you're busy." Such protectiveness tends to keep the technology and its application a secret book of rites open only to the initiate. Perhaps, because of the exclusionary nature of their own profession, physicians are preconditioned to the notion that work functions are sacrosanct, not to be interfered with or questioned unless gross misfeasance becomes evident.

Consider, however, that in the telemedicine medium we interact with electronic artifacts— artifacts of faces and voices, expressions and emphases, gestures, projections of personality, role, self-perception. Do we really want to give the responsibility to someone else to determine how we, as artifacts of ourselves, are presented to others? Do we want to abdicate responsibility for presentation of artifacts of what we are and what we do, as well as the information we present and the way we present it?**

Once professional users perceive that what is mediated in the interactive environment is nothing short of the totality of practice or learning experience, there can be little reason or excuse to maintain distance from the technological component. Conversely, if technicians are to develop equipment that is responsive to physicians' special requirements, they must approach physicians' work functions in the spirit that a medical writer does, and assume they will be granted the same sort of open detailed response the writer receives.

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* The pacemaker enhances information which the physician wants delivered to the cardiac muscle by informing the muscle to behave on a rhythmic basis, something the physician would otherwise find it difficult to do. The ECG on the other hand enhances information about various electrical discharges in the heart muscle by delivering the information in a standardized manner which the physician is able to interpret.

** One might ponder, as well, McLuhan's observation that "the 'message' of any medium or technology is the change of scale or pace or pattern that it introduces into human affairs." [4]

Only a few years ago professional motion-picture making demanded six years or more of apprenticeship in a single craft, such as cameraman or editor, before the individual was allowed to do the work and possess the title. Today, young men and women are learning all they need to know to produce motion pictures of high quality in a few years, and doing everything themselves, from camera to sound to editing to mixing. With the advent of inexpensive television cameras and video tape recorders, the same thing is now happening with television. The process has been called "demystification." A medium is demystified when its associated technology can be understood and used by anyone who is interested in doing so.

The anthropologist, Edmund Carpenter,[36] says, "Electricity makes vast amounts of information available to all. Photography is a mass of data in a flash. In this vastly confusing environment, the problem becomes one of data selection and processing, forcing everyone to abandon the position of consumer and become instead a co-producer." The requirement falls heaviest on those who are engaged in processing information in a setting like telemedicine.

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CHAPTER IV

Current and Pending Telemedicine Projects

As of January 31, 1974 there were twelve telemedicine systems in operation in the U.S. The Cambridge Telemedicine Project had just gone out of existence but its experience still is instructive. The first thirteen projects that follow were, therefore, the "operational" projects in existence in late 1973 and early 1974. Data relvant to these projects such as transmission modes, equipment in use, network configurations, services provided, and operating schedules are presented in a standardized manner in Appendix A. This has been done in order to preserve a narrative format in this chapter. *

Six funded projects which were to begin operations later in 1974 or 1975 are also described in this chapter. They are numbered 14 through 20. Transmission, equipment and service data on these six have been included in the narrative.

1. BETHANY/GARFIELD COMMUNITY HEALTH CARE NETWORK

The Bethany/Garfield Hospital complex in Chicago, consists of two community hospitals (Bethany Brethren and Garfield Park), three storefront health centers and three drug rehabilitation clinics. The complex is community-controlled and jointly administered. Facilities are located on four non-adjacent properties in an area approximately a mile square.

The problems faced by the complex in meeting its commitment to providing the best possible health care in an urban ghetto are typical of those faced by similar institutions throughout the U.S. These problems include limited funds and personnel as well as a high incidence of crime, disease and disability. Geographical separation creates difficulties for physicians and administrators, since the salaried physicians who serve the clinics also attend to patients in both hospitals and a nearby nursing home. Trips between these facilities are time-consuming. The 109,000 residents of the community go to any of the outpatient clinics or hospital emergency rooms despite the fact that their own physician practices elsewhere. Patient records are needed at all sites and there are difficulties in keeping them up to date when patients use more than one facility.

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* The reader will note that the University of Nebraska Slow Scan Radiology Project is unlike all the others in that it does not transmit pictures in motion. It has been included because it represents an interesting alternative to fully-interactive television and is relatively inexpensive. It does provide two-way audio and "still" pictures of reported high fidelity. Slow Scan is also to be utilized alongside broadband television within the Miami and STARPAHC projects (numbers 15 and 18, respectively).

Administrators must keep in touch with personnel at all locations in order to make the many decisions that cannot await periodic staff meetings, but frequent visits to all sites consume considerable time.

The two-way telecommunication system installed in 1972 in the Bethany/Garfield complex links both hospitals, two health centers, and one of the drug clinics via a user-switched network of Picturephones (R).

Objective

This network's primary objective is to explore the use of telecommunications technology, both Picturephone and broad-band television, in solving the communications problems of a large health care network in an urban ghetto.

Planning, Training, Implementation

Initial planning was done chiefly by the Hospital Administrator and his Department Heads. The Administrator feels he should have involved some of the ultimate users in the planning stage, even though one cannot assume that anyone on the staff, at any level, is going to know precisely what will happen once the system is in place. Early involvement can produce positive attitudes toward an innovation.

Furthermore, evidence of the practicality of involving subordinate staff is gained from two subsequent developments. First, many of the 19 Picturephone locations have been changed, and some changed twice, as experience has shown greater and more productive utilization at locations different from those originally planned. Second, supervision of pharmacy assistants by a registered pharmacist was developed by the pharmacist after the system was operative. This use may save the hospital complex the full salary of one pharmacist, a sum nearly equivalent to a year's rental of the Picturephones.

Because of a number of technical problems, there were constant changes during the planning period,* and there was insufficient analysis of the locations which would provide optimal utilization. In the case of the Picturephones this could be and was remedied.

Training - Picturephones

Local Bell System instructors trained the staff personnel prior to Picturephone installation. The instruction was reasonably thorough although limited to generalized, not specifically health-oriented applications, yet the more enthusiastic future users asked questions which were not answered at the time. However, since installation, a Picturephone expert from Bell Labs has spent considerable time at Bethany/Garfield, eliciting complaints and suggestions. He has devised helpful adaptations in the form of special hardware,* and has suggested useful approaches to system utilization, with minimal additional equipment, such as close-up lenses.

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* Originally, disc-scan converters were to be interfaced with Picturephones, in order to store, retrieve and display X-rays and records. This proved infeasible. Then it was decided to substitute a wideband system separate from the Picturephones, linked by cable; when elements of the cable link proved too costly, a system was designed which utilized microwave, laser, and infra-red transmission.

Implementation - Picturephones

The delays in implementing the Picturephone circuit created adverse reactions from physicians as well as nurses and administrative personnel. The consensus went something like, "With all the things we need around here— including pay raises—why are we spending money on something that doesn't work?"

Once the Picturephone system began functioning, the staff began to use it with increasing frequency for a variety of tasks.

Counter devices on the individual Picturephones, which give fairly close approximation of number of calls placed and aggregate time in use has enabled the administration to assess the use of the instruments in the various locations and to change some instruments to places where it was felt that utilization would be greater. **Also, an evaluator could note the frequency and duration of use thus correlating gross utilization with function by interviewing users and reporting their mention of critical incidents.

Implementation - Wide-Band Equipment

The use of the wide-band equipment has been considerably impeded by frequent malfunctioning combined with poor repair and maintenance performance by the supplier. This has led to growing disinterest in this TV mode. It is understandable that a physician cannot be persuaded to "give it a try" when the equipment fails in the middle of a transmission or will not function at all when he attempts to use it.

Acess to records, using video-disc storage in connection with wide-band equipment, also has been impeded by the excessive down-time of the broad-band equipment.

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* The hardware includes a stand that permits the instrument to swivel several degrees and a special adaptor for display of prescriptions.

** During the first 50 days of trial, Picturephones were used in 728 transactions, for a total of 39.1 hours; transactions averaged 3.3 minutes. At this juncture, six Picturephones were moved to different locations. (See "Diagram of System," in Appendix A.) During the second 50 days of trial, 1316 transactions were logged, for a total of 69 hours; transactions averaged 3.15 minutes. Relocation accounted for a net increase of 580 transactions; net increase from instruments not relocated was 8, although seven non-relocated instruments showed an increase of 166 over previous transactions. Five instruments where use had decreased in the second fifty days were relocated on October 3.

When it is functioning, the medical records section can reproduce and store requested records for immediate retrieval by professionals at other points of the system complex. The staff hopes that the broad-band equipment function can be restored, because patients often present themselves at different locations from one visit to the next.

Utilization

The Hospital Administrator states that he and his staff want to retain the Picturephones after the expiration of current funding, and to initiate both Picturephone and wide-band interaction with tertiary medical centers in the area for specialist consultation and staff training.

Physician reaction to Picturephones generally has been positive, following an initial period of skepticism. Physicians are using Picturephone communication to arrive at decisions they say they would not make if they were using only a telephone. Picturephones have facilitated in-service training and medical staff conferences. No longer do some personnel need to go from one building to another. A newly-placed Picturephone in the computer section facilitates communication from there to the admission and business offices about missing, unclear, or incorrect entries. It is estimated that 40% of interactions between the pathology laboratory and staff at any remote area in the complex are influenced positively by Picturephone use. This correlates with the number of interactions in which sender or receiver has English as a second language; visual transmission of findings and microscopy obviates the language problem. The Hospital Administrator estimates Picturephones have cut in half the time of the many transactions he has with staff. These transactions require personnel to see each other for face-to-face accountability.

Evaluation

Apart from positive subjective experience an attempt is being made to evaluate the impact and effectiveness of the visual component. This is being done by collecting a sub-set of critical incident data on all days at all terminals, by measuring gross utilization, and by gathering impressions of acceptability and impact through a periodic staff attitude questionnaire, patient attitude interviews, observer studies of use, and staff interviews about the equipment.

Finally, an evaluation committee made up of staff will select those critical incidents which merit in-depth detailed and quantitative analysis on the basis of frequency of reporting and relative importance. The Committee also will suggest other areas for research.

Success criteria are straightforward:

1. The system has achieved a level of acceptance by staff, and is being utilized.
2. The system is meeting needs and is utilized consistently for significant, identifiable purposes.

3. The needs for which it is being used could not be met as well by other means.

2. BLUE HILL— DEER ISLE TELEMEDICINE PROJECT

Rural, isolated populations face critical problems of maldistribution of physicians and medical facilities in meeting their needs and expectations for health services. For example, the State of Maine has less than one million people spread over 33,000 square miles of land area, and 60% of its population resides in communities which are served by hospitals of less than 100 beds. There is little inter-community bus service in Maine and no passenger train service. Two-lane undivided roads are the chief connections between communities. Automobile travel in the summer usually is satisfactory, but in winter snow storms often make the roads impassable and fell telephone lines so that many rural communities are totally isolated for hours to days.

This is the setting of the telemedicine link operating between Blue Hill on the mainland and the physicianless community of Stonington on Deer Isle. Blue Hill and Stonington are approximately 25 miles apart; a two-lane road, much of it in poor repair, is the only land link between the towns.

Objectives

One initial objective included linking of primary,* secondary and tertiary care institutions via interactive telecommunications, so that the benefits of interaction among all levels of the delivery system could be realized. Shortage of funds made it necessary to eliminate links between Blue Hill (secondary) and Bangor (Eastern Maine Medical Center, tertiary) personnel and facilities. The remaining objectives include:

- A demonstration that two-way interactive television can be used to improve the distribution and quality of medical services in rural areas.
- A demonstration that sophisticated technology can provide one means for solving problems of rural medical service delivery which have defied solution by conventional means.
- A reduction in the prohibitive social and economic costs of total medical care for the people of Deer Isle and Blue Hill by reducing travel, hospitalization, separation from family, and acute sickness due to lack of early detection or regular care.
- The provision of a "laboratory" for applied research in the utilization of new technologies and techniques for delivering medical services to rural areas for use by medical students, interns, residents, and practicing physicians.

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* The primary care institution is the Island Medical Center, at Stonington, built by the community in hopes of inducing a physician to settle there, but to no avail.

Planning, Training, Implementation

Planning

Beginning in 1969 representatives of Maine's Regional Medical Program, the Eastern Maine Medical Center in Bangor, Blue Hill Memorial Hospital and the Island Medical Center at Stonington amassed data, employed local engineers and the MITRE Corporation as consultants, canvassed the local population, * and finally designed a system to respond to the needs and resources of the area. The talents of many of the area's leaders in medicine and health care were tapped. Although its major source of funding, Maine's Regional Medical Program, was facing extinction when the plan was finally ready for implementation, the initial planning work had been so solidly accomplished that the Blue Hill to Deer Isle link still was funded.

Training

Orientation and training for use of the equipment was limited, as in most telemedicine applications, to the barest essentials of operation.

Implementation

The large, well-equipped medical center at Stonington is now manned by a full-time nurse practitioner, frequently assisted by nurses and other nurse practitioners who are members of the Family Nurse Associate Program which serves communities on Deer Isle. A large examination room in the Island Medical Center contains the telemedicine equipment, consisting of a camera which takes a wide shot for interaction, a close-up camera for examination of the patient and associated monitors and microphones. The close-up camera can be controlled by the physician at Blue Hill. Telemedicine equipment at Blue Hill Memorial Hospital was originally placed in the hospital library. New construction, however, now provides a special room for the use of consulting physicians.

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* A random survey in the summer of 1970 elicited the response from 82% of those queried (32 of 39 families) that they would use a community health center or health clinic if it were available. According to the survey, members of the 39 families questioned had made 117 visits to various medical personnel in 1969. One key question asked in the survey was, "Would a specially trained nurse be acceptable if you knew that she could discuss your children's health with a doctor at any time and that the doctor would see the children at scheduled times when well and at any time when sick?" 97% of the parents in the sample responded affirmatively. In answer to the question, "How far do you have to travel to see your family doctor or nurse/doctor?" 54% indicated they had to travel 15 miles and over. This fact, alone, could account for the high degree of utilization of this rural telemedicine link.

Considerable assistance from the Maine Educational Television Network has enabled this telemedicine link to be established and maintained. Should the Bangor-to-Blue Hill link be built, it would then be possible to provide specialist back-up not only to Blue Hill but, at relatively less expense, to a number of other community hospitals in the area.

Utilization

In its first nine months of operation, the Blue Hill-Deer Isle link was used almost exclusively to provide the nurse practitioner on Deer Isle with consultative services. Toward the end of 1973, ambulance attendants on Deer Isle began to receive training in first-aid and primary care of the sick and injured via the telemedicine link.

The greatest use of the system was on weekdays when the nurse practitioner was in attendance. The large number of transactions per month (70-90), and the fact that the system was in use somewhere between 45 and 60 hours a month indicated the high degree of dependence which was being placed on the system.

By mid-winter 1973-74, however, an apparently contradictory phenomenon became evident. Utilization of the telemedicine link had fallen off by perhaps a third during the winter season even though winter's rigors constituted a principal reason for the link's existence. The Project Director feels the two reasons for this are fewer accidents in the winter and the absence of the "summer people" from the island. Furthermore, in cases where she, herself, does not feel a need for consultation via the telemedicine link, the nurse practitioner nevertheless frequently suggests that the patient may wish to address further questions to one of the physicians at Blue Hill. Permanent residents make fewer requests to see "a real doctor" than the summer residents. The Projector Director believes that permanent residents have developed a higher degree of confidence in the nurse practitioner. *

Evaluation Most of the telemedicine projects which began operations in late 1972 or 1973 have not completed their evaluations. In this project, a number of evaluative steps are being undertaken. Interviews are being conducted to elicit patient satisfaction. Patient records are being analyzed to determine: The number of people in Deer Isle who receive medical care different from what was experienced prior to the telemedicine link; the number of infants born prior to the telemedicine link who received no prenatal care, as compared to the number of infants who received prenatal care via the telemedicine link; the quality of medical care through peer review of records; comparisons of patient waiting times under the old and new systems; the

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* It is possible, of course, that socioeconomic and cultural differences are involved. The more affluent city-oriented "summer people" may be exhibiting a readier acceptance of technology as well as a mix of skepticism and trust about medical practice different from local residents'. Local residents may see the technology more conservatively and the nurse as having relatively greater authority than summer residents do. Unlike the "summer people," locals may simply be less questioning in a situation where they are being provided a level of health care superior to what they got formerly.

comparative amounts of patient and physician travel times under the old and new systems; and a comparison of the total annual costs of medical services using the new and old systems and the costs per patient served.

Because of its isolation and dependence on external provision of consultation, the community on Deer Isle should provide an accurate picture of "before and after" factors vis-a-vis telemedicine.

3. CAMBRIDGE TELEMEDICINE PROJECT

Objectives

The overall objective of the Cambridge, Mass., telemedicine project was to use audiovisual links between three neighborhood health satellites and a city health center, Cambridge Hospital, to facilitate physician interaction and consultation with nurse practitioners and patients. Specifically the project anticipated collecting data to define further studies of hierarchical systems which deliver primary care under the supervision of a health center.

Planning, Training, Implementation

The system was planned with research as its major outcome. Questions of efficiency, number of referrals, quality of consultation vis-a-vis effectiveness of nurse practitioners in planning treatment of problems, patient satisfaction, and ease of utilization were considered.

Training

Nurse practitioners, trained to administer primary care, were to contend with an estimated 75% of complaints, without needing consultation or referral. Written protocols established and delineated practice standards. Training in use of the telemedicine equipment was limited to bare essentials: turning equipment on and off, focusing lenses and adjusting audio levels.

Implementation

Each location had a camera, a large monitor for interaction, a small monitor to see the picture being transmitted from the location, and a microphone. There was a half-inch videotape recorder at the hospital. Each of the clinic locations was equipped with a headset (earphone and microphone) in a room adjacent to the tele-station for private communication between nurse-practitioners and consultants.

The tele-center at Cambridge Hospital was in the obstetrics-gynecology out-patient suite on the ground floor. The four internists who rotated as consultants for the system went to the tele-center only when a consultant was requested which meant leaving their usual stations on the seventh floor. Thus the physicians had to interrupt their routines and take an elevator down to the tele-center; nurse practitioners had to wait from three to six minutes with their patients for consultations.

Utilization

One nurse-practitioner used the telemedicine equipment in each of the three health centers. Two of the centers had an additional nurse-practitioner who only used a telephone for consultation. For study purposes television use was compared with telephone use since both modes were being utilized by nurse practitioners in the three clinics. To accomplish randomization of consultation requests, nurse practitioners found out which mode they would be using each day when they called for their first consult. On any day, two clinics used television and one used the telephone. The television links were used only for consultation.

The following table reflects the first two months when nurse practitioners #'s 1, 2, and 4 used telemedicine or telephone, as required by the random procedure; #5 was the other nurse practitioner stationed at the clinic with #1; #7 was teamed with #4; #'s 2 and 6 worked alone; #6 was stationed at a fourth clinic which had no telemedicine capability.

N-P	#1 (T/M & Tp)	#2 (T/M & Tp)	#4 (T/M & Tp)	#5 Tp	#6 Tp	#7 Tp*
% of cases in which consult was requested, both T/M & Tp	30%	18%	35%	4%	23%	25%

On the average, nurse practitioners who had television available, asked for more consultations than those who did not have it, but they did not ask for consultations via television at a higher rate than via telephone. The average telephone consult in the first two months of operation lasted 4.44 minutes, while the average television consult lasted 7.85 minutes. Furthermore, physicians began requesting that the nurse practitioners include themselves "on camera" and thus become a greater part of television interactions.

Television and telephone consultations were most frequently requested in the following specialties: skin; eye; ENT; respiratory; cardiovascular; endocrine and metabolic.

The following complaints were characteristic of non-consult patients: general (includes no code available; allergy; hay fever; feeding problems; FUO; physical exam; post-operative followup; problem undefined; viral syndrome; no abnormality; GI; GU; GYN; musculoskeletal; CNS-Psychiatric; blood-lymph; infectious disease; and trauma.

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* T/M = Telemedicine User Tp = Telephone User
N-P = Nurse Practitioner

Evaluation

Participants and others observed that this system probably put television consultation at a disadvantage for these reasons: the inconvenience to both physicians and nurses; television consults consume more time than telephone consults; motivation to ask for consults probably was influenced by the fact that it was relatively easy to send a patient to the hospital.

The principals in this project emphasized the particularity of their experience, and cautioned against extrapolating from it without taking into account its many unique aspects.

Five hypotheses were tested:

"1. Television will sufficiently increase the quality of the physician-nurse practitioner consultation that the efficiency of the nurse practitioner visit will increase. Stated another way, we anticipate that the productivity of a given nurse practitioner will increase if high quality consultation is readily available.

2. Television will improve the consultation, so that fewer referrals of patients to the central facility or of physician to the neighborhood station will be required.

3. Television will improve the quality of the consultation so that the presenting problem will be more rapidly identified and a treatment plan more quickly and specifically formulated.

4. The personalization of the television consultation will result in a higher level of satisfaction for the patient.

5. The use of a visually augmented consultation will increase the satisfaction and decrease the discomfort of both physician and nurse practitioner about a remote consultation."

Preliminary analysis of the first two months' experience provided some tentative conclusions, discussed below under numbers corresponding to the hypotheses:

1. Efficiency of the nurse practitioner visit was affected adversely by the length of time required for television consultations. Mean time from request of consult to end of consult on television was 13.38 minutes, as opposed to 7.69 minutes for telephone. This was a result both of the delays in starting TV transactions and greater time required in TV consults (7.85 minutes, as opposed to 4.44 minutes on telephone). However, in the period studied, it was not possible to look at learning curves of both physicians and nurse practitioners for parameters such as length of consult, frequency of consults and preference for television or telephone. Whether television gave nurse practitioners more understanding of diagnosis and treatment because of in-service training is unknown.

Principals noted that, prior to beginning the telemedicine experiment, nurse practitioner #4 was rated by the participating physicians as having attained the highest level of qualification among the six nurse practitioners, and nurse practitioner #5 as having attained the lowest qualification of the group. Utilization showed that #4 subsequently requested consultation for 35% of the patients seen and #5 requested consultation for only 4%. The correlation, though interesting, remains unexplained, and may be worth investigating.

2. Television consults led to more referrals (33% of consults referred) than telephone consults (25% of consults referred). However, in the case of TV consults, 27% were referred to physicians visiting the clinic, usually at a later date, and only 6% to physicians at the hospital. In the case of telephone consults, 14% were referred to visiting clinic physicians and 11% to hospital physicians.

3. Overall time taken for television consults was twice as much as for telephone consults, so that the operative adverbs "more rapidly" and "more quickly" are rejected in this hypothesis. Whether television improved the quality of consultations or treatment plans remains open to question. Principals stated they were unsure about this, but felt it may reflect sub-optimal use of the telemedicine system. Neither nurse practitioners nor physicians showed a statistically significant preference for either mode (television or telephone) over the other.

4. Patients were reported equally satisfied with consultations conducted by telephone or television. It was noted later, however, that clinic patients were beginning to make more frequent references to the telemedicine link. A characteristic comment would be, "I've come because I've heard you have TV, so I know you're in direct touch with the hospital." This may indicate an assumption on the patients' part, however naive, that television certifies "being in touch" more positively than the telephone does.

5. Although television would appear to have similar status to telephone as a consultation medium (see 3, above), Cambridge principals noted other factors which lend some validity to the "satisfaction" hypothesis for both physicians and nurse practitioners:

   - Although television consults produced more referrals than telephone consults, less than a fifth were made to hospital physicians, whereas almost half of the referrals produced by telephone consults were made to hospital physicians. This has been taken to mean that hospital physicians were satisfied with the information they received via television and comfortable that it was somewhat more sufficient than the information obtained via the telephone.

   - Physicians and nurse practitioners have said, frequently, that they "enjoyed" the television relationship. Note, also, the physicians' requesting nurse practitioners to appear more on camera which may have been an attempt on the part of physicians to use television to "normalize" the situation.

- Nurse practitioners said they felt television often got them "off the hook," because the consulting physician could see a patient whose problems verbal description alone might have left open to some degree of doubt or ambiguity.

Comment

Although one would agree that this experiment probably did place telemedicine at a disadvantage, it is interesting to observe the many positive reactions registered by users. Some users expressed willingness to explore further applications with a system better suited to their needs.

This experiment strikingly illustrates a situation common to many of the short-term projects funded in 1972 by HCTD:

- Due to constraints on both time and funds, the system was implemented minimally. Cameras and monitors were more than adequate, but their location was inconvenient for physicians and inflexible in the clinics.

- Because of the understandable requirement to evaluate the project, hypotheses were proposed prior to any experience with the system, apparently on the assumption that telemedicine is somehow a known quantity against which utilization can be tested. It was difficult, perhaps impossible, to gather unequivocal data in support or rejection of hypotheses unless hedged with caveats to cover the unforeseen variables that appeared.

- Training in use of the system was practically nil. Perhaps again, it was assumed that telemedicine technology and the interactive medium are somehow "plug-in" facilities that provide visual/auditory contact that adequately simulates face-to-face interaction. But it is now apparent to those gaining experience in telemedicine that there are correlations between training and efficiency and effectiveness in telemedicine.

4. CASE WESTERN RESERVE SCHOOL OF MEDICINE ANESTHESIOLOGY PROJECT

Approximately 50% of all anesthesia in the United States is administered by non-physician anesthetists. Gravenstein* and others claim that patient morbidity and mortality risks are reduced when a physician-anesthesiologist is in attendance. Maldistribution of anesthesiologists results in inadequate coverage in many hospitals. Thus, many nurse anesthetists are forced to work without access to an anesthesiologist-consultant. This color television project links an operating room at the Cleveland Veterans Administration Hospital with an anesthesia monitoring room in Lakeside Hospital of the University Hospitals Complex at Case Western Reserve University. Transmission is accomplished via low powered He-Ne laser beams.

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* J.S. Gravenstein, M.D., Director and Professor of Anesthesia, Case Western Reserve School of Medicine, Principal Investigator of the project.

Objectives

The prime objective of this project is to evaluate whether two-way, wideband audio-visual and data communications may be used to remedy the shortage of anesthesiologists. A well-staffed hospital would provide anesthesia care to several other remotely located hospitals through telemedicine. At any one time, one or more anesthesiologists at the central hospital would supervise the actions of a much larger number of 'physician assistants' at several remotely located operating rooms through the means of the wideband communications channels."*

Thus a second objective is to obtain data to help evaluate the benefits and cost-effectiveness of a "one physician-many assistants' system. The project principals make the point that, "The one anesthesiologist supervising one nurse anesthetist is practically without interest as an ultimate system but is very useful in this preliminary stage. Similarly, despite the wording of the title, [An Experiment in Using Two-way Wide Band Audio, Laser Link to Permit an Anesthesiologist to Supervise a Nurse Anesthetist] laser communications has little to do with the true objective of this contract study. It is being used in lieu of microwave or cable because the latter two types of wideband communications were not readily available. Fortunately, experience has shown that the laser aspect of the communications channel did not intrude into the experiments."

"The outcome is to be considered positive

a) if presently available technology in remote manipulation and data acquisition techniques are found to be adequate and reliable for the purposes of anesthesia care.

b) if anesthesia personnel at both ends of the telemedicine link accept the link and find it sufficient for the intended purposes. This medical evaluation will include use of the link by anesthesiologist-physician assistant teams.

c) if the medical anesthesia care delivered in this way by anesthesiologist-physician assistant teams is considered to be as good as that which could have been delivered by the anesthesiologist if he had been on site."

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* Quotes in this section are from the first Semi-Annual Report to HCTD by Gravenstein, Pao, and Stickley, Case Western Reserve University School of Medicine, unless otherwise noted.

Planning and Implementation

Planning

Considerable thought went into the rationale for using two-way television in supervision of an anesthetist by an anesthesiologist and to devising a workable system.* However, human factors had to be considered. Television, as opposed to telephone, was required because only by observation can the anesthesiologist "time his questions and comments so that they do not occur during inopportune moments when they would be either a disturbance or could not be perceived because everybody's attention was occupied elsewhere. "The question was: where can you see what you want to see with minimal intrusion into the operating room with all its constraints?"** In other words, where should cameras and monitors be placed so as to permit maximum visualization for the distant anesthesiologist and optimal two-way video communication between anesthesiologist and anesthetist?

"At first the camera with which we wanted to view the patient was suspended from the ceiling on an empty operating-room-lamp holder. The camera was to give a picture of the patient's face and, after adjustments, of the operative field. The camera position was well accepted by the nurse anesthetists and operating room personnel, but adjustment of the camera by hand, which required adjustment of focus by hand, was found to be intolerable. It diverted attention, required manipulation of an object to which the team was not accustomed, and invited attention to a disturbing intrusion. In addition to this, during conversation with the nurse anesthetists, instinctively the nurse would look at the monitor in which the consultant's picture appeared. This monitor was attached to the wall and the nurse would therefore gaze to the wall, thus turning her back to the camera viewing the V.A. operating room."

"Conclusion:

1. In a successful monitoring system the equipment in the operating suite to be monitored must be automatic. Requirement for manipulation by the personnel to be monitored is not acceptable.

2. In a two-way situation, the TV screen presenting the picture of the consultant to the team to be monitored must be located next to the camera that is monitoring the team. The person being monitored will look at the consultant on the monitoring screen during conversation with the consultant."

"We have not attempted to work the system without a monitoring screen on which the consultant would appear. However, we believe that it is essential for reassurance of the team being monitored; the consultant can be identified, his facial expressions can be read and reassuring cues are available to the clinical team that will have a natural tendency to be apprehensive about criticism, scorn or riducule."

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* The engineering work, to accomplish proper signal strengths via a combined laser-cable television system was carefully executed. Coaxial cable is used for signal distribution within hospital structures. Laser is employed to transmit between the hospitals.

** J.S. Gravenstein, personal communication.

"Based upon these experiences, we next located the monitoring camera on the wall next to the TV screen that presents the consultant's picture. While this facilitated conversation with the nurse anesthetists and the consultant, who could now see each other face-to-face, it made the nursing team in the operating room much more self-conscious because not only the patient but their activities could be viewed by the consultant. Several sessions of discussions with the nurses and reassurance was necessary in order to overcome this inhibition."

"The rigid mounting of the monitoring camera in the operating room made it impossible to focus in on details. The next step, therefore, was the introduction of the pan-tilt-zoom focus and iris apperture-control operated remotely from the monitoring station at the University Hospital."

Thus, after a trial and error period this project came to precisely the sort of set-up already arrived at in other systems. Even though the O.R. setting is very different from a primary care clinic the human interaction that is facilitated when cameras can be remotely controlled and participants can see each other seems to have been compelling to all who have discovered it or otherwise come to it.

From the anesthesiologist's point of view, however, the wall-mounted color camera alone does not provide all the visualization that he or she would prefer. The wall-mounted camera gives a good side view of the patient's chest and enables inspection of the instrumentation, tanks, meters, drug labels, etc., which are color coded for identification. On the other hand, only one side of the patient is seen, and the view of the operation site is poor. An overhead mounted camera would obviate most of these difficulties.*

The first camera position attempted was suspended from the ceiling. At the time, difficulties were encountered in adjusting it by hand, but this was not the reason it was finally deemed infeasible, since remote controls could have been used, as in the present wall-mounted camera. Secure ceiling mounting would have been very expensive, and once mounted directly over the surgical site the equipment would have become a repository and dispenser of dust.

The anesthesiologist views the anesthesia record by switching to a second, monochrome, camera which is in fixed position.

Technical problems have not arisen from the complex system design but have arisen with camera remote controls and the camera signal selector, both of which were purchased as stock manufactured items. The principals state: "These problems are apparently due to inadequate design..."

The project was fortunate in having the services of the head of the Division of Electrical Engineering and Applied Physics of the School of Engineering as well as of the Director of the Health Sciences Communications Center at Case Western Reserve.

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* J.S. Gravenstein, personal communication.

Together, these men evolved a series of technological improvements so that the technology now responds well to human needs and is no longer obtrusive, the equipment functions very well, and it has been shown that there is no significant difference in transmission brought about by the use of a laser. There are further human factors improvements that could be made in this system, such as allowing the anesthesiologist a full 360 degree pan and tilt mechanism. However, to a considerable degree the present system does facilitate the necessary interaction and makes it possible to isolate and evaluate the basic hypothesis of this experiment: that use of a two-way wideband audio, visual, and data communications over a laser link will permit an anesthesiologist to supervise a nurse anesthetist.

Plans for a larger system are underway. Two more small hospitals in the Greater Cleveland area would be linked to the University Hospitals on the assumption that a single anesthesiologist can safely direct as many as three anesthetists by this remote method.

Utilization

This link has been in regular use since it became operational. Several video tapes have been made of transactions between anesthesiologist and anesthetist during the course of operations. Tapes were made with patients' knowledge and permission and are used strictly for professional purposes. These have proven useful from a number of standpoints: The videotapes document a number of critical incidents which demonstrate the utility of the telemedicine link. A number of actual scenes from just eight procedures have been described by the principals. Following is a sample:

"Scene 2: Topical anesthesia is applied and the anesthesiologist advises the nurse anesthetist on how to prevent absorption of the local anesthetic and thus a toxic reaction. Actual observation of the technique employed by the nurse anesthetist was necessary to trigger this comment by the anesthesiologist."

"Scene 3: Nurse anesthetist applies adhesive to the eyes to prevent damage to the cornea in an unconscious patient whose face will be draped. Because the anesthesiologist could observe the manner in which the tape was applied, it was possible to change this application and make it safer."

"Scene 4: On scanning the operating room, the anesthesiologist finds that the patient's right elbow is resting on a steel bar of the operating table. This can lead to nerve damage in the unconscious patient. It was corrected on instruction by the anesthesiologist."

"Scene 5: The TV system allows us to read labels, for instance on bottles of intravenous fluids. In this instance it was discovered that dextrose in water was given and the suggestion was made to change it to a solution containing salt."

"Scene 7: When the patient arrives in the operating room, he is seen to cough. Without this observation of a coughing paroxysm, questions about pulmonary status might not have been elicited."

"Scene 9: The system allows us to see whether or not an i.v. is running or whether it is running too rapidly."

"Scene 10: In preparation for a difficult intubation with a double lumen tube the patient's ability to open his mouth is inspected."

"A truly unusual sequence has been taped where a nurse anesthetist inserts a so-called Carlen's tube. Here was an example where a technical procedure is made possible because a manually skillful nurse anesthetist is instructed via the system to go through a technically complex procedure. This is brought to a successful conclusion. It should be emphasized that the nurse anesthetist had no previous experience with this procedure and the successful completion of the procedure under the guidance by a remotely positioned consultant is a spectacular demonstration of the utility of the system."

"Scene 15: Another recommendation that requires visual contact is on the position of the patient. Here the patient is brought into a head-up position in preparation for induction of anesthesia in the presence of a full stomach. The position is controlled visually and the position adjusted until it is satisfactory to the consultant."

"Scene 16: Scanning the operating room and discovering a disconnected ventilator. This is quickly corrected. Presumably the nurse anesthetist in due time would have discovered it also, but probably only after some vital signs in the patient had indicated inadequate ventilation of the lungs."

Having these tapes available allows participants to review the course of the procedure. If the anesthesiologist needed to correct the nurse anesthetist during the procedure he or she can now go back over this point with the anesthetist and explain in somewhat greater detail the background reasons for the correction. Interaction between users and technologists is facilitated. The anesthesiologist can point out something that he or she was prevented from seeing or could not see very well. By understanding what it was that the anesthesiologist wanted to see and how he or she wanted to see it, the designers can make adjustments to meet these needs. The visual explanation of the techniques involved provides a very useful training tool. Finally, these videotapes become useful to the evaluation process.

Evaluation

The basic objective of the telemedicine system has been to bring the expertise of anesthesiologists into operating rooms or Intensive Care Units as supervisors of non-physician anesthetists. Efforts have been focused on development of methods to evaluate the effectiveness of telemedicine in accomplishing this objective.

Components of evaluation include these factors:

- Economic
  (Installation Costs, Insurance, Maintenance)
  (Personnel, Provisions ensuring that the system can pay for itself.)

- Technical
  (Transmission Equipment, Display and Monitoring Units)

- Medical
  - Accessibility
  - Capability
  - Effectiveness
  - Efficiency
  - Cooperation

- Attitudinal
  - Physicians
  - Nurse Anesthetists
  - O. R. Team
  - Patients

Evaluation to date has focused on developing a scoring model. Weights are assigned to various sub-factors within the above categories. Questionnaires are filled out by participants, mean scores are arrived at, and corrected in terms of factor weights. Since system performance can be evaluated by subjective and objective observations, the evaluations are scored in terms of relative importance of the information obtained.

Long-range evaluation of economic factors will become more meaningful as additional links are added to other hospitals needing supervision of anesthetists.

In the view of the principals, it is "clearly not ethical" to employ controlled experiments in medical evaluations. Nor can comparisons be made between retrospective and prospective data since these could be "fraught with bias."* Evaluation will proceed from "situations that led to a change in medical management. For this, recordings of transmitted signals, consultants' opinions and actual patient records will be obtained and the situation will be analyzed retrospectively by a panel of experts. Another evaluation will be carried out by... a silent observer [in the remote hospital] and comparing his evaluation to that of the... consultant who had access only to transmitted data."** Attitudinal research is to be conducted through questionnaires, while technical research is based on gathering hard data on reliability and maintainability.

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* These quotes are from a new Case-Western grant application to implement links to two additional hospitals.

** Ibid.

5. COOK COUNTY HOSPITAL DEPARTMENT OF UROLOGY, PICTUREPHONE$^{(R)}$ NETWORK

This is the only telemedicine project which is self-funded, which has received no funds directly from some agency of the federal government.

The Chairman of the Department of Urology at Cook County Hospital in Chicago felt that an audio-visual telecommunications system could give him and his staff more opportunity to engage in visual and verbal interchange with patients and with each other.

Objectives

The founder of the project states,* "In this era of multiple new health delivery care systems which seem to be more concerned about the type of bottle rather than the quality of the milk, our experience with a TV telephone system reaffirms the great benefit of visual contact, overt concern, and relaxed verbal interchange. Medical personnel are basically a dedicated group often misdirected in their approach to patients. The concept that speed (and brusqueness) saves time and that the use of 'please,' 'thank you,' and 'may I' can be overlooked because patients and co-workers 'realize' that you are really 'nice' but are pressed by the more serious problems of life and death, is archaic. The use of our system allows physicians to maximize their time, minimize effort and present to the patient the face of quiet concern." Basically, then, the objectives of this system are to improve administrative control and patient care, and to test some questions arising from the hypothesis that more personal interaction is better than less personal interaction.

Planning, Training, Implementation

Planning

The Department of Urology had had considerable experience in the use of television videotape, both in black and white and in color for teaching and informational purposes. When the Picturephones became available in Chicago (very limited experiments with Picturephones were undertaken by the Bell system in 1971) it seemed a natural step to request the opportunity to experiment with them. Ten Picturephones were installed in locations under the control of the Department of Urology, and therefore became a departmental concern.

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* Bush, Irving M., M.D., Chairman, Department of Urology, Cook County Hospital, "A Ten Station Picturephone System in the Modern Delivery of Urologic Care." (Unpublished manuscript.)

Training

It is a policy of the Department of Urology at the Cook County Hospital to show patients that members of the staff are concerned about them, care about them. The staff is encouraged to know the names of all patients, what their occupations are, and something about their lives and their problems. Picturephone is an extension of this "caring" posture. Staff members are instructed to use it to establish contact and relationships with patients. In order better to use the Picturephone it was recommended to the staff that, when using the Picturephones, they set the instrument for the "view self" mode. In this way, the caring professional sees not the patient but himself/herself and begins to get a view of the way in which his or her manner is projected to the patients. Thus, the Picturephone becomes a training aid for patient contacts rather than merely an end in itself. In order to facilitate operation of the Picturephone, however, most users, when they begin use, are encouraged to go through the entire directory of other available terminals. They call each of the other terminals in their own system in order to make sure they understand the operating technique.

Implementation

Instruments have been emplaced as indicated in the diagram (in Appendix A., page 217 "Diagram of System"). A few special adaptations have been made in the Picturephone instrument for cystoscopic viewing. Remote control of a zoom lens on one Picturephone in a new operating room allows a remote observer unobtrusive access to a reasonably good field of view.

Utilization

The Picturephone system is used routinely by the Department of Urology. An average of 45 calls per day are logged. The major user of the system is the Department Chairman, who effectively employs it to facilitate running the Department. Of the average 45 calls per day, at least half are from or to his office.

The Chairman of the Department feels that telemedicine transactions via the Picturephone take less time than face-to-face transactions and are more focused because the physician can count on a very high degree of efficient preparation prior to the initiation of a call to him. He never sees a patient until the patient is ready to be seen, and is not obligated to continue seeing the patient after he has gained sufficient information from the transaction to arrive at a secure disposition. The Chairman finds he can get considerable work done during the period of time in which he is accepting a number of Picturephone calls. At the termination of any call he can go to routine work and continue with it until another call is ready, at which time he can give it his full attention.

Further discussion of utilization is deferred to the following section on "Evaluation."

Evaluation

Fundamental objectives in the establishment of this Picturephone system were to improve administrative control, to improve patient care, and to test a number of questions springing from the basic hypothesis that personal interaction, facilitated in this case by Picturephone, is superior to other communications modes.

With regard to the question of improvement of administrative control, the Chairman of the Department feels that his time is far more efficiently deployed, that he has a constant and current impression of the matters which are of concern to his Department. He attributes this to the ability to attend to almost any matter which is in question at the time that the question arises.

No precise evaluation of improvements of patient control has been made. However, it is noted that patients have been very receptive to physician interviews. One comment from Dr. Bush's paper* is interesting in this regard: "One of the main complaints that patients, in general, express is that most doctors, even in private practice, seem to be too busy and do not give enough personal attention. The television system gave most patients the impression that the doctor was with them exclusively and that he was not harried or hurried and was individually concerned. Most patients stated that the system worked well and would be happy to use it again." At this juncture, Dr. Bush injects a personal note which is equally interesting: "This is exactly opposite to what would be expected. I feel that used as an aid in conjunction with 'hands on' care that the system is acceptable. If used exclusively, the patient gets the feeling of being isolated and disregarded."

Experiments, cited above, were performed as follows: (All quotation marks refer to the paper previously cited.)

1. A video telephone was used to monitor the activities in a cystoscopy suite. "It is possible to review retrograde and cystogram X-rays and to display endoscopic pictures to distant locations from the cystoscopy room. Also cases can be reviewed with the referring physician, pathologists, radiologists and other urologic attendings. The results were surprisingly successful. In some instances, the X-ray presented could be seen better over the video system because we were able to brighten and to darken poor quality films. The film displays are smaller than the normal X-ray films, but they are remarkably sharp and easy to interpret. In addition, a better evaluation was possible because cases could be intelligently discussed with the referring physician, pathologist, and other concerned physicians."

2. An experiment was run to demonstrate that a urologist could be available for emergency consultation within several seconds to several minutes. "This was only partially successful, in that emergency room personnel in many instances forgot to think of the system. This was probably due to the fact that the system was only being used by urology. However, when it was used, it was an effective way of reaching the urology resident on call, having the urology resident interview the patient, and decide on the course of treatment or possible referral to clinic, X-ray, etc."

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* Ibid.

"The urologist often sees only the patient, and he is unaware of the patient's non-urological problems. By using this system, it certainly saves the patient, the hospital, the nurses' and physicians' time in addition to getting a better overall evaluation of the patient. There is less chance of misunderstanding and incorrect diagnosis, and the initiation of false therapeutic regimens."

3. Can a Picturephone allow personnel on one ward to cover another ward in time of emergency or when ward nurses are busy with some other tasks? "The Picturephones can be focused down the ward and kept on for a period of two hours. Personnel on one ward can cover the other ward with ease, being in full voice and visual communication, at all times, though a significant distance away."

   "Picturephones can also be used to visually monitor ill patients or groups of patients from either ward, so that though a nurse be busy with preparing medications or with some other task, she or a companion nurse can specifically monitor the patient. In addition, the responsible physician can visibly check his patient though he is in clinic or in cystoscopy."

4. Four experiments were tried to determine whether the TV telephone is another example of the dehumanization of medicine. These were followed by added experiments e-h below.

   "a) Initial interviewing: Patients who presented at hospital emergency room or urology clinic were introduced to the physician on the TV telephone and the initial interview performed. Department volunteers then interviewed patients using a detailed questionnaire."

   "b) Prior to rounds: Prior to rounds, attending physicians would interview those patients upon whom therapeutic decisions were to be made by TV telephone. After rounds these patients were interviewed by the department volunteers in a similar manner."

   "c) Sexual interviews: Patients being seen in a sexual dysfunction clinic were interviewed by Picturephone about details of their sexual problems. Clinic staff personnel would then interview the patients about their reactions to the physician, the use of the TV telephone, and how to improve the technique."

   "d) Weekly patient gripe sessions: Each week a letter was distributed to every in-patient on the urology service stating that if there was any difficulty or any problems the patient could speak privately to the Chairman of the Department between 1:00 and 2:00 p.m. on Wednesday. After speaking to the Department Chairman, the patients were interviewed by Department volunteers as to the concept and the method."

   This is the point at which the statement is made "in general, the patients were very receptive to physician interviews. Initially, doctors had some problems interviewing patients over the phones, but after using them for a short period of time, this posed no great problem."

"The TV camera is a hard task master and one has to learn quite specifically how to radiate warmth and confidence. The residents, and for that matter every physician who has used the system, has learned something about how he speaks to patients and how he can improve his patient communication. Many physicians never look directly at or speak 'with' their patients. They have been able to correct this problem to a certain degree by using the view-self capability of the TV phone while interviewing patients." It would seem that the opportunity here presented is not so much to evaluate the Picturephones as to evaluate the physicians.

"e) Can X-rays be effectively viewed, 'transported' and interpreted throughout the system: We were able to get X-rays more efficiently from the files and were able to view them in the clinic, cystoscopy room, wards, etc. In addition, with the use of single view boxes so as to prevent glare from other sources of light, the X-rays were interpretable in most cases. Both the camera and the receiver have a brightness control which can be adjusted; thus electrically improving over-exposed and under-exposed film. In addition the capability to zoom in on certain areas of the X-ray and magnify areas is at times a distinct advantage."

"f) What value does the Picturephone have in facilitating monitoring of operating room activity? Last week we installed a zoom camera monitor system into one of the operating rooms which allows for two-way communication. The viewer, pathologist, referring physician, etc., by the use of control buttons on his distant set can pan, tilt and zoom in on the operating field and see a clear view of the procedure. In addition, the operator can request X-rays from radiology, speak to the pathologist (possibly in the future view frozen sections) and better handle any emergency that arises in the hospital complex."

"g) Testing the ability of the physician to monitor patients in the recovery room while the physician is working somewhere else: This was partially successful. We were unable, until recently, to mount the unit on the wall so that most patients had to be viewed at a distance. A new monitor which is five feet from floor level is being permanently installed which will allow for close-range viewing and monitoring of individual patients."

'h) Does the system improve the care of the patients and the supervision of the staff? It is easy to see how from the supervising point of view, that this system allows the Chairman of the Department to be in direct personal contact with every aspect of his department. On the other hand it allows residents, staff, and patients immediate access to him with minimum interference with his work. This improves care in that all services and personnel are integrated into a single team."

6. ILLINOIS DEPARTMENT OF MENTAL HEALTH MEDICAL CENTER COMPLEX/ COMMUNITY MENTAL HEALTH PROGRAM PICTUREPHONE NETWORK

The network of 12 Picturephone stations links staffs of institutions which comprise the front-line and expert backup of a decentralized community mental health program in a poverty-ridden Chicago ghetto. The mental health program has been active since 1967. Addition of two-way visual telephony was made possible by HCTD grants in 1972 and 1973. Picturephones have been operational since September, 1973.

The brief history of the Picturephone project strikingly illustrates the necessity for involving as many prospective users as possible in early planning stages. *

The initial proposal on which this project was funded generalized the communication problems of decentralized mental health care in Chicago's near West Side Black/ Hispanic ghetto:

"1) Providing experienced staff at a specific location— and at a specific time— to evaluate the circumstances of a client/patient in a crisis situation;

"2) To facilitate the transition of the client/patient as he moves from one service component to another;

"3) To provide instant information (including portions of medical records) between two components who may be working concurrently with a patient/client or members of his family."**

The project's current principals would not take issue with the above. However, in responding to these problems their approach is somewhat different from the former approach and has been changed as a result of introducing broad participatory involvement in re-planning.

Originally, it was planned to measure the number of communications of each of the units involved and attempt to measure the quality of those communications. A communications sociometric questionnaire to measure quantity was developed by Flynn and Kroe. This questionnaire presented the participants with little difficulty. However, the semantic differential measure for assessing the quality of communications, which asked participants to rate their communications with other units as good/bad; warm/cold; efficient/inefficient; effective/ineffective, caused the staff members to balk. They refused to give such information. Hence, the researchers had to be satisfied with the measures of their communications network that were indicated by answers to the sociometric questionnaires. When these data were organized and collated, group sociometrics for each unit were drawn and the unit's staff was asked to comment on what the sociometric was saying and to amend any false impressions given by the graphs. It was interesting to note that the staff members now felt free to discuss attididinal factors of their communications. As a result of these presentations and discussions, uses for the Picturephones are evolving.

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* Most planners would accept this statement as a truism, yet many seem to redefine it when planning is undertaken to mean "heads of departments" or "a representative sample." Often, in actuality, one finds that planners go ahead without involving anyone except themselves and a few prospective users with whom they feel comfortable and to whom they have ready access.

** "Technical Proposal, The Illinois Department of Mental Health Medical Center Complex," 1972.

Although the Picturephone's functions would allow patient-staff consultations and intake interviews, these are being held in abeyance until the staff feel comfortable with the technology. Also, staff at the in-patient units are being encouraged to communicate with staff members at the outposts over various functions, e.g., training, referral, etc.

As a result of these feedback sessions, staff attitudes toward the project have changed. Formerly, hostility and cynicism were characteristic, but now the people are entertaining possibilities for usage in light of their communication functions and the work of their unit.

Objective

Initially, the objective was to "explore the utility of two-way visual communication between one or more storefront clinics staff by paramedical personnel and a hospital or other source of expert consultation." This still is true, but the possibilities have become more focused. Now the goal is to get a commitment to use the Picturephone for a particular purpose, which the unit, itself, has defined and recommended. Again, usage on the part of staff first is of paramount importance since, if they do not feel comfortable with the technology, the patients certainly will not.

Planning

Initial planning called for 21 Picturephones, nearly twice the number made available in September, 1973. In order to facilitate assessment of patients, therapy, consultation, and other contacts initiated by paraprofessionals at outposts, the bulk of the video telephones were to be placed so the psychiatrists and superiors in the hierarchy of the Community Mental Health Program would have ready access to them. Questionnaires and logs were developed to gather data on utilization, effectiveness, problems, and attitudes. It was understood that these instruments would apply not only to patient care but also to training, administration, and conference functions.

When the Picturephones finally were operational in September, 1973, it became apparent that indeed planning had not taken into account the attitudes and desires of staff. The staff openly refused to be subjected to questions about their attitudes toward communication with other units and used the system infrequently and in a desultory fashion.

Just prior to the system's operation the present Project Manager and Research Assistant had joined the project. Their impression was that few if any of the staff cared if the Picturephone Network was used or not. Faced with staff resistance to assessing the potential utility of two-way visual communication, but unencumbered by previous association with it, the two had to readjust their methodology.

A methodology was developed which has not appeared in earlier telemedicine projects. A sociometric model of existing communication patterns is constructed by each of the individuals who is a likely prospective user of the video telephones. The model starts out looking like this:

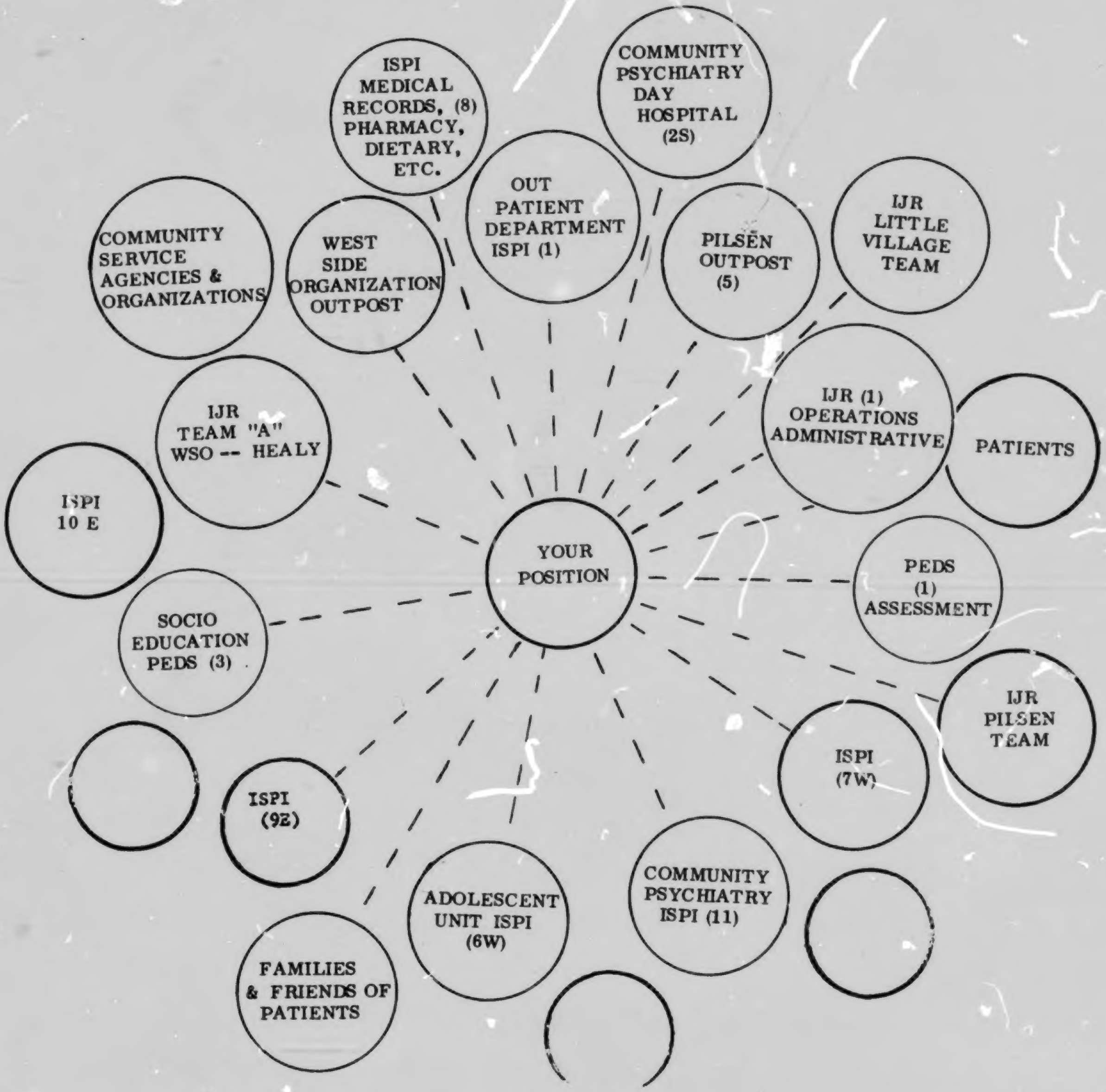
COMMUNICATION SOCIOMETRIC

COMMUNICATION FUNCTIONS
A. community or social services
B. referral
C. diagnostic/evaluative services
D. threatment/therapeutic services
E. operations/administrative support
F. training/education
G. research

COMMUNICATION FUNCTIONS RANKED BY IMPORTANCE TO YOUR WORK
1.
2.
3.
4.
5.
6.
7.

NAME___________________
DATE___________________

YOUR UNIT OR PROGRAM____________________


ISPI MEDICAL RECORDS, (8) PHARMACY, DIETARY, ETC.
COMMUNITY PSYCHIATRY DAY HOSPITAL (2S)
OUT PATIENT DEPARTMENT ISPI (1)
COMMUNITY SERVICE AGENCIES & ORGANIZATIONS
WEST SIDE ORGANIZATION OUTPOST
PILSEN OUTPOST (5)
IJR LITTLE VILLAGE TEAM
IJR TEAM "A" WSO -- HEALY
IJR (1) OPERATIONS ADMINISTRATIVE
PATIENTS
ISPI 10 E
YOUR POSITION
PEDS (1) ASSESSMENT
SOCIO EDUCATION PEDS (3)
IJR PILSEN TEAM
ISPI (7W)
ISPI (9E)
COMMUNITY PSYCHIATRY ISPI (11)
ADOLESCENT UNIT ISPI (6W)
FAMILIES & FRIENDS OF PATIENTS

Each working unit of the Community Mental Health Program has a Picturephone assigned to it and the staff receives the following instructions:

COMMUNICATION SOCIOMETRIC INSTRUCTIONS

The following instructions are for guiding you in filling out the communication pathways and functions which correspond to your current position with the Illinois Mental Health Institutes. The communication processes you will be describing should be from the standpoint of your personal work responsibilities and not those of your unit or team as a whole.

1. Draw a solid line between your unit and those units or locations with whom you maintain any regular communication, either by telephone, memo, letter, meetings, or whatever. (By "regular" is meant any communication even if it is as seldom as once every few weeks but is important for your work.)

2. The cluster of twelve inner circles on the "Communication Sociometric" represents the twelve stations that currently make up the picturephone network of the Illinois Mental Health Institutes. The outer circle contains a number of blanks. Use these blanks to fill in all the units of I. M. H. I. or outside agencies or persons with whom your work brings you in regular contact. Fill in as many of these circles as you need to depict the full spectrum of your communications outside of the picturephone network. Draw in solid lines between your unit and circles you have filled in.

3. In the upper left hand corner of the Communication Sociometric is a list of seven functions of communication: A, B, C, D, E, F, G. Along side of each solid line (communication pathway) you have drawn list by letter the communication functions it serves or facilitates. For example:

   YOUR UNIT ———————— OTHER UNIT

4. Above each letter (A, B, C, D, E, F, G) you have placed along a pathway draw an arrow to indicate the direction in which services are flowing as a result of the communication. The arrow does not describe who initiates the communication but who is giving and who is receiving the service. For example, if you are providing a diagnostic consultation the arrow would point away from your unit out to the unit you are providing the consultation; if you are referring a patient out to another unit the arrow would point back to your circle since you are requesting the service of the other unit.

   YOUR UNIT ———————— OTHER UNIT

5. Looking at all the communication paths (Solid lines) you have drawn, rank them (with numbers placed inside each circle) from one (1) to twenty-two (22)--the maximum--with number one (1) representing the pathway with the highest volume of communication of all kinds, and each subsequent number representing a diminished volume (amount of time). If two or more have the same relative volume, assign them the same number or ranking.

6. In the upper right hand corner is a seven (7) level scale for ranking communication functions. For each of the seven functions (A, B, C, D, E, F, G) you have used to describe the communication which is important for your work, rank it in terms of its overall importance in accomplishing your work or training objectives.

A typical completed form would look like the one immediately following. From the individual sociometrics a group sociometric is drawn, such as the example after the individual form.

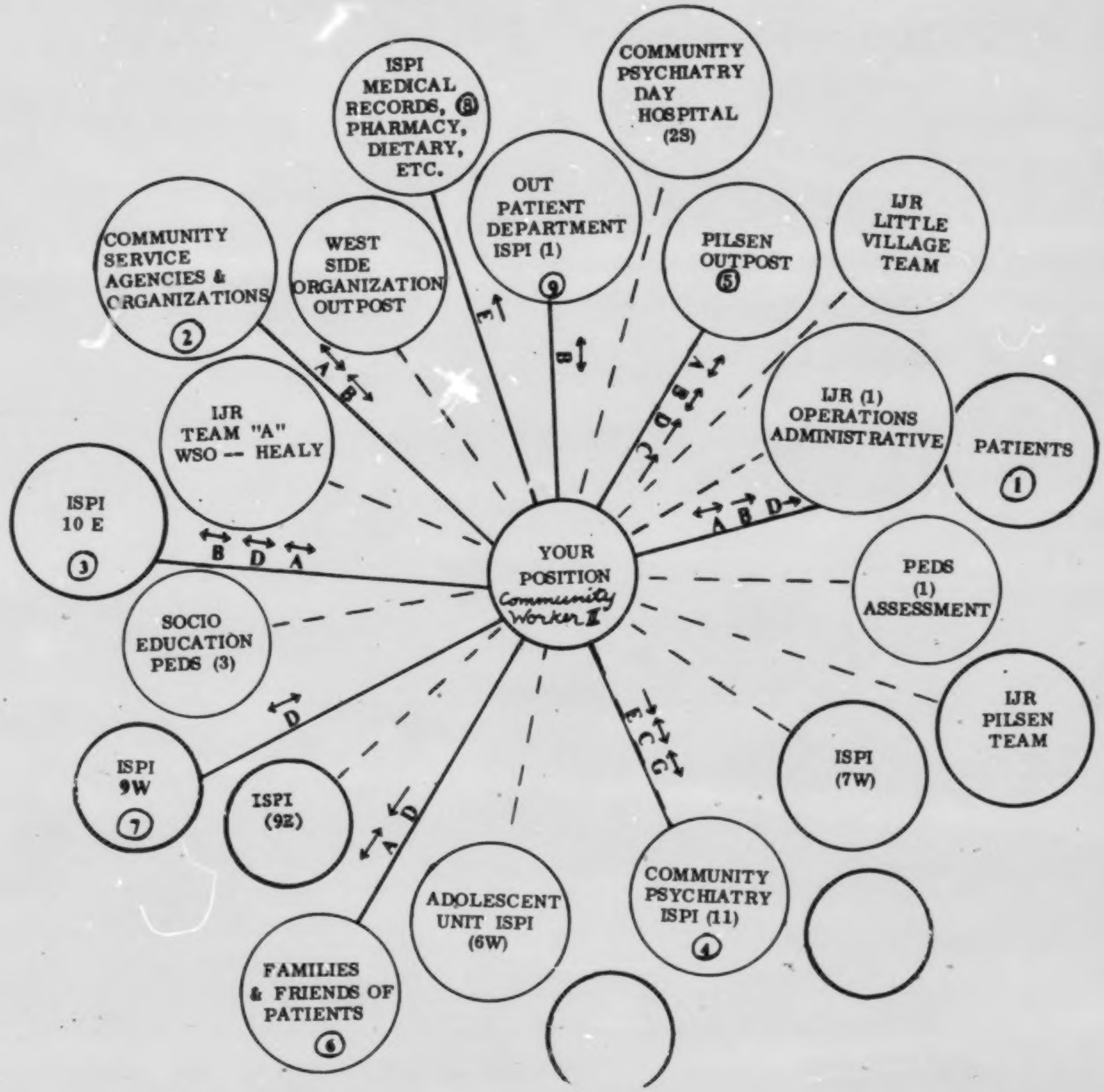
COMMUNICATION SOCIOMETRIC

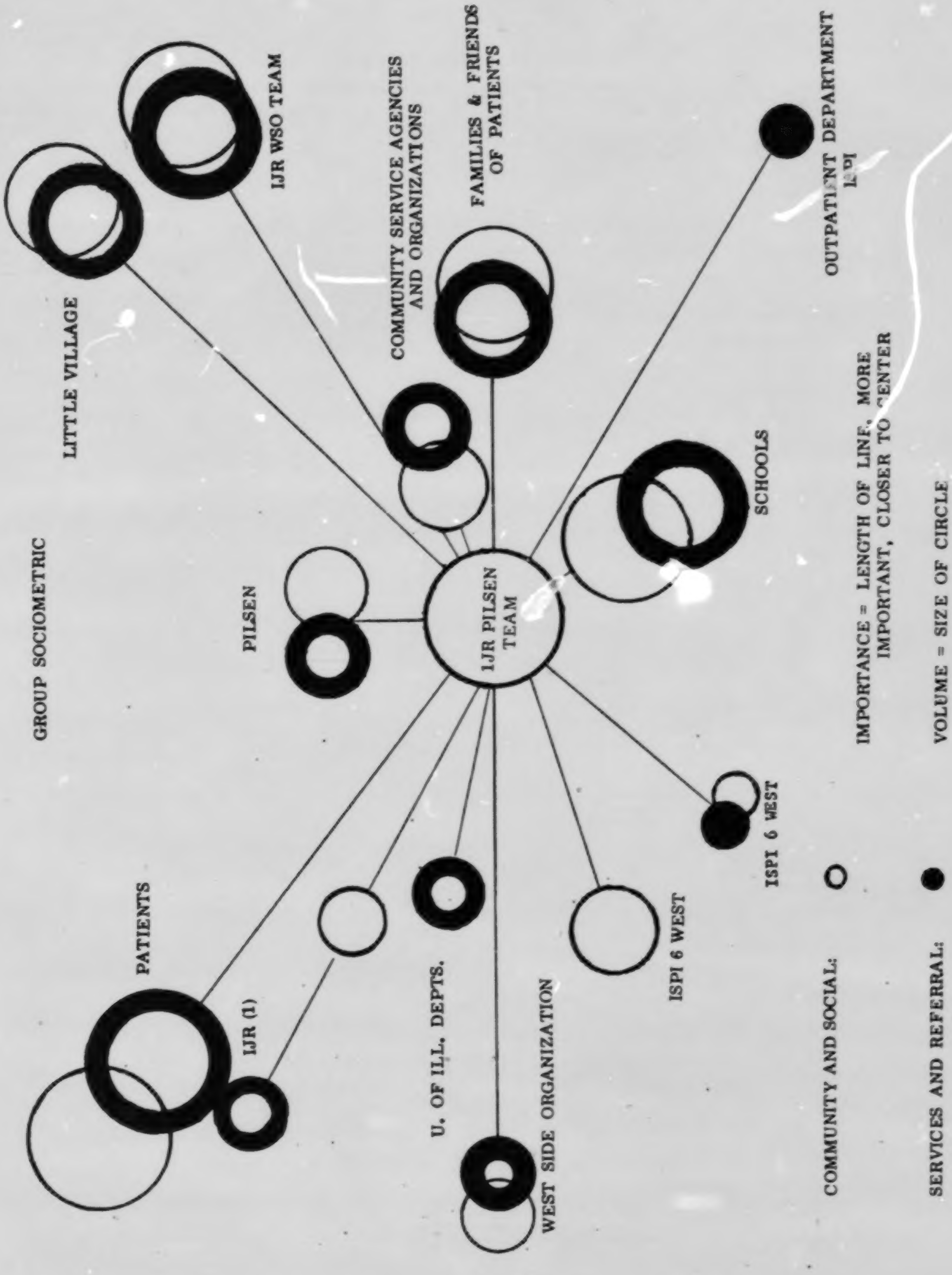
COMMUNICATION FUNCTIONS
A. community or social services
B. referral
C. diagnostic/evaluative services
D. treatment/therapeutic services
E. operations/administrative support
F. training/education
G. research

COMMUNICATION FUNCTIONS RANKED BY IMPORTANCE TO YOUR WORK
1. A
2. D
3. B
4. C
5. E
6. G
7.

NAME
DATE 2 - 14 - 74

YOUR UNIT OR PROGRAM L V Team


ISPI MEDICAL RECORDS, PHARMACY, DIETARY, ETC. ⑧
COMMUNITY PSYCHIATRY DAY HOSPITAL (2S)
OUT PATIENT DEPARTMENT ISPI (1) ⑨
COMMUNITY SERVICE AGENCIES & ORGANIZATIONS ②
WEST SIDE ORGANIZATION OUTPOST
PILSEN OUTPOST ⑤
IJR LITTLE VILLAGE TEAM
IJR TEAM "A" WSO -- HEALY
IJR (1) OPERATIONS ADMINISTRATIVE
PATIENTS ①
ISPI 10 E ③
YOUR POSITION Community Worker II
PEDS (1) ASSESSMENT
SOCIO EDUCATION PEDS (3)
IJR PILSEN TEAM
ISPI 9W ⑦
ISPI (92)
ISPI (7W)
ADOLESCENT UNIT ISPI (6W)
COMMUNITY PSYCHIATRY ISPI (11) ④
FAMILIES & FRIENDS OF PATIENTS ⑥
A B
E
B
A B D C
A B D
B D A
E C G
D
A D


GROUP SOCIOMETRIC
LITTLE VILLAGE
IJR WSO TEAM
COMMUNITY SERVICE AGENCIES AND ORGANIZATIONS
FAMILIES & FRIENDS OF PATIENTS
OUTPATIENT DEPARTMENT ISPI
PILSEN
IJR PILSEN TEAM
SCHOOLS
PATIENTS
IJR (1)
U. OF ILL. DEPTS.
WEST SIDE ORGANIZATION
ISPI 6 WEST
ISPI 6 WEST
IMPORTANCE = LENGTH OF LINE, MORE IMPORTANT, CLOSER TO CENTER
VOLUME = SIZE OF CIRCLE
COMMUNITY AND SOCIAL: ○
SERVICES AND REFERRAL: ●

Volume of communication is indicated by the size of the circle, importance by length of line. The shorter the line, the more important is the communication. In the above example, the IJR Pilsen Team has a small volume of important communication with Pilsen, but a larger amount and more important communication with schools.

Analysis of communication patterns prior to adding two-way video telephones produced the following:

- A realization on the part of many people that the overall pattern of their unit is different from individual's patterns and therefore interest about that difference was awakened;
- Suggestions as to use of video telephones in those patterns where importance is a significant factor opened up the thinking of individuals about their own use of the instrument.
- Focused thinking about communication as a means by which tasks are accomplished and learning achieved, prompted the following realizations.

At unit meetings prospective participants now see that visual communication could allow them to participate from an outpost in hospital conferences at which cases of in-patients from their area are being reviewed. They suggested that hospital training sessions would be easy to attend via the Picturephones. Furthermore, they could review hospital records of patients who have moved from another part of the West Side into their area.

Utilization

The Project principals believe utilization of video telephones is now on the increase, and they have meters to count frequency of usage and duration of time used. Their concern is that utilization ultimately should grow from users' perceived needs. At the moment of this writing, the principals are still conducting unit meetings based on analysis of communication patterns and attempting to focus on patterns before use of the video instruments. This is a conscious attempt to avoid being the sole promoters of the Picturephones. The principals hope that users will take the initiative and suggest how the equipment should be used and request necessary implementation, such as changing Picturephone locations, scheduling conferences, etc.

Evaluation

Over time construction of sociometric communication patterns will begin to show certain changes as video-telephones become more widely used. Correlation between communication patterns and data from counters installed on Picturephones will yield measurable dependent variables. The counters, as in the Bethany-Garfield project, will show numbers of individual calls and gross aggregate time spent on all calls.

7. LAKEVIEW CLINIC BI-DIRECTIONAL CABLE TELEVISION SYSTEM

The Lakeview Clinic, in Minnesota, is one of two telemedicine projects exploring the utility of two-way visual communication among the members of a geographically dispersed group practice in a rural area. The other is demonstrated by Rural Health Associates in Farmington, Rangeley, and Kingfield, Maine.

The project is based on the two Lakeview Clinic facilities at Waconia and Jonathan, Minnesota, and the Ridgeview Hospital in Waconia. The two towns are approximately 13 miles apart, while the clinic and hospital in Waconia are a half-mile apart. (See Appendix A for relevant data).

Objectives

The following is quoted from "A Preliminary Report on an Experiment in A Bi-Directional Cable Television System To Support A Rural Group Practice," which was prepared for HCTD by Northlands Regional Medical Program, Inc., Lakeview Clinic, and Community Information Systems, Inc.:

"The implicit outcomes and objectives of the project... include the following:

"1. Behavioral changes on the part of participating physicians in the

  a. time devoted to movement from one facility to another
  b. time devoted to the care of patients
  c. use of specialists or consultants for the diagnosis and management of patient problems unique to the specialist or consultant
  d. number of patients seen on a daily basis
  e. involvement of allied health personnel in patient care.

"2. Behavioral changes on the part of allied health personnel in

  a. communicating patient problems to the patient's physician
  b. participation or involvement in the decision-making process concerning patient care.

"3. Attitudinal changes on the part of participating physicians in their

  a. acceptance of the audio-visual system as an integral component of patient care
  b. willingness to lease two-way channels and terminal A-V equipment in the future.

"4. Attitudinal changes on the part of allied health personnel associated with the A-V system in their

a. acceptance of the system as an integral component of patient care
b. willingness to master the techniques of transmission and to cooperate in carrying out the technical aspects of the A-V system.

"5. Changes in the nature and scope of the participation of the patient in the health care process where the A-V system is used including:

a. a better understanding of his health problem
b. less time waiting to see his physician
c. fewer movements from one facility to another
d. a feeling of greater personal attention to his problem by physicians and other health care personnel
e. increased satisfaction with the care he receives
f. willingness to pay a fee for use of the equipment.

"6. Willingness of third party payor to reimburse or pay a subscriber for use of the audio-visual system.

"It is anticipated that the A-V system will enable physicians to discharge patients from the hospital without personally seeing the patient at the time of discharge, resulting in fewer days of hospital stay. Finally, the use of the system will provide better patient care than that previously provided when consultation took place only over the telephone or no consultation occurred because of lack of a communication system.

"On the other hand, the immediate cost of care may increase simply because of the expense associated with starting, operating, and maintaining the A-V system. The extent to which costs increase and who will bear these increases (clinic, hospital, patient, or third party payor) represents a fundamental dimension of this study, requiring extensive exploration and evaluation."

Planning, Training, Implementation

Planning

The project was planned by Lakeview Clinic and Community Information Systems, Inc. (CIS) which is devoted to pioneering in advanced technologies of cable communications, particularly in two-way interactive systems. CIS officials consulted with several members of two top-level national groups, The National Academy of Engineering's Committee on Telecommunications and The Ad Hoc Interagency Committee on Urban Telecommunications, to elicit the widest possible range of information as to technological capabilities for medical and other uses.

Planning was substantially aided by the recent addition of the Jonathan branch of Lakeview Clinic. Jonathan is a new town planned for an ultimate population of 50,000 by 1990. Its current population is approximately 2,000. As the community grows, it will become the gravitational center of an area comprising eight or nine older and

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smaller rural towns. To the extent that telecommunication facilitates delivery of health care services, it could influence changing patterns of health care throughout the area. The planning included a detailed technological scheme to facilitate communication among the three locations, as well as detailed plans for collecting data on utilization.

Training

The following is quoted from the "Preliminary Report" cited above:

"The continuing orientation and training process ranges from informal conversations to scheduled briefing sessions, complete with flip charts and video-taped aids. Training is conducted by the physician project director, CIS engineer, and CIS behavior research analyst."

"Several weeks elapsed between the first equipment briefing for nurses and the first medical transmissions. This period allowed the allied health personnel to assimilate the training gradually and to practice with the equipment before being pressured to use it professionally. A refresher meeting with hands-on practice was conducted with the clinic nurses just as medical transmissions were beginning. The group of physicians received a formal briefing on the equipment,* and were given individual training sessions at their request and convenience."

"In general, the content and pace of the training has been designed to engender enthusiasm and confidence. Enough technical detail is provided so that the health personnel can use the equipment effectively and, in a limited way, trouble-shoot their own errors and minor malfunctions."

Project personnel at the leadership level have continued to conduct informal "refresher" training exercises as the need has arisen. Unfortunately, the level of training has not been uniform for all of the participating personnel, with the result that, on occasion, users have become frustrated by their own inexperience or lack of understanding of equipment operation. This is not to imply criticism, but to recognize an essential reality. Physicians in busy practices are unwilling to give much time to studying the equipment or experimenting with it, therefore, when the opportunity to use the equipment arises inexperience often makes for a less than satisfactory transaction.

Implementation

It was determined that equipment requirements would permit bi-directional audio and visual contact among any combination of the two clinics and the hospital, be usable in various locations in each building, provide sufficient resolution for close-up, X-rays, EKGs, charts, etc., and be easily operable by physicians and allied health personnel.

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* Video carts. See Figures 5, 6, and 7 in Chapter I.

These requirements were implemented in the design of the mobile video carts. Each video cart is a self-contained local origination unit capable of generating television pictures plus sound, and transmitting this information to either of the two other locations in the bi-directional network. The cart can simultaneously receive information from two remote sites and record or play back prerecorded TV pictures plus sound. Major components of each cart are: two TV monitors, two TV demodulators, two RF converters, three RF splitters (2-way), one RF band pass filter, one TV modulator, one TV camera, one video distribution amplifier, one TV video tape recorder (video cassette), one audio/video switcher, one control panel, three microphones, one audio mixer, three audio amplifiers, one speaker, one electronic stethoscope consisting of stethoscope, transducer and heart sound filter, and one audio tape recorder.

Each video cart is literally a complete television station. All patient care facilities at Ridgeview Hospital are equipped with recepracles into which a single coaxial cable from the mobile video cart may be introduced. Transactions and monitoring of patients can be conducted from individual patients' rooms, the emergency ward, intensive and coronary care units, and several larger rooms in the hospital used for conferences.

The video carts in the clinic locations tend to remain in one fairly large examining room at each site. It is simpler to designate one such location to which patients can be brought, since they are all ambulatory, than to attempt to move the carts into and out of heavily utilized examining rooms.

Remote control of the distant camera is not available. Health care personnel attending patients must adjust the camera view, size of image, focus, and iris according to voice commands from the distant viewer. Although participants in this project contend that lack of remote control has not proven a hindrance, telemedicine users in other locations where remote control is available feel that most interactions are facilitated when the viewer can perform these functions directly.

Full implementation of this system was delayed due to unforeseen technological difficulties. The two-way amplifiers in the cable required re-designing when it was discovered that they were insufficiently shielded against electromagnetic disturbance from distant television and radio stations. Design modifications were suggested by CIS and accomplished by the manufacturer who supplied the original hardware.

Utilization

Unanticipated utilization accounts for a substantial amount of the overall use of this system. Of the approximate 200 transmissions as of January 25, 1974 about 1/3 involved consultation/diagnosis and follow-up examinations, 1/3 included the transmission of data (EKG, X-ray, chart), and about 1/3 were monitoring of patients and conversations.

For evaluative purposes, each transmission is classified according to its medical content, the cost-benefits produced by the transmission, a probable communication alternative to the transmission, the difference in medical care between care via transmission and care via the probable alternative, the difference in medical outcomes produced by the transmission, and whether the transmission produced a major, minor, neutral or negative benefit. The unanticipated uses evolved because of their perceived values, whereas those categories for which the system was intended seem to have posed a larger number of problems for utilizers. The unanticipated uses for the system include the following:

- monitoring of patients in the delivery room
- monitoring of patients in the intensive and coronary care unit
- opportunity for a physician to check for himself on the progress of newly-admitted patients. It was anticipated that physicians would be able to see patients via television for the purpose of checking them out of the hospital.
- opportunity for allied health personnel to use the system for in-service educational and training purposes
- ECG and X-ray transmissions enabling immediate reading and feedback from a specialist, including comparison of the current ECG and/or X-ray with previous ones on file at the other location
- three-way conversations between consultant and patient at the hospital and primary physician at the Clinic have been conducted, with certain consultants actually promoting this opportunity so that both physicians can be certain that all parties understand precisely the findings and the follow-up procedure.

The Project Director* tells of the following situations which were difficult to evaluate objectively:

- A one-year-old suffering from acute asthma was brought into the clinic at Waconia. The physician had the patient admitted immediately to the hospital and placed in a tent with high humidity. Medication was to be administered, as needed, under observation. The physician remained at his office in the clinic, seeing patients. He found that he was preoccupied by concern for the asthmatic child, felt he was not concentrating to the fullest extent on his clinic patients, and observed that he was behaving impatiently toward his nurses. Telephone conversation with the nurse attending the patient in the hospital did not sufficiently alleviate his concern. When he finally remembered he could view the patient directly, he ordered the video cart be plugged in at the patient's room. The physician was able to see for himself that his patient was responding well to the treatment. As a result the physician's behavior became more normal and relaxed in the clinic setting.

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* Jon Wempner, M.D. Personal communication.

- A child with bleeding from the bowel was admitted to the hospital for diagnosis. Upon admission a radiologic exam showed the presence of a small polyp, a diagnosis different from the one originally presented to the mother. Additional explanations to the mother by hospital personnel were unsatisfactory. The primary physician at Jonathan spoke to the mother on the telephone a number of times, but still could not reassure her. The professional personnel tried to convince her that the recommended operation would result in minimal danger. At this point, the primary physician asked that the mother be brought to the video cart at the hospital. He then proceeded to draw a diagram and to explain it over the television link. This sufficed to clear the air and the recommended operation proceeded on schedule.

- One of the physicians at the clinic had seen a five-year-old patient with asthma, had him hospitalized, and left instructions for treatment. The physician was called away to Minneapolis. One of his associates then became responsible for the patient. The patient's condition had been fairly well under control in the morning but became worse in the late afternoon. The nurse called and told the second physician she was concerned because the patient was retracting quite a bit. At this point the physician in charge asked her to take the video cart to the patient's room and call him back. He was able to see the extent of the child's retraction, that the child was obviously in distress and so ordered medication administered. An hour later the physician called to see the patient again and was able to see that there had been little relief of symptoms. At this point he started treatment with additional medication. When the physician was finished with his work at the Jonathan Clinic, he was able to go to the hospital about 8:00 in the evening and see the child in person. By that time the patient's asthma was under control and he was doing much better. The physician states that he would not have been able to make decisions via the telephone, and without television, would have had to call in still another physician to go to see the patient.

The Lakeview Clinic regards most uses of its telemedicine link as adjunct to the care it is providing. Therefore, brief informal conversations on the cable link between general practitioners and specialists are not charged to the patient. Consultations with outside specialists via the telemedicine link are chargeable. Recently, in cases when a patient must see or wants to see a clinic physician and cannot make an appointment to see that physician in person at one of the clinics, a small charge ($2.00 to $3.00) has been made for use of the link based on time and travel saved for the patient. No formula has yet been devised to determine precisely how the telemedicine facility will be supported. There are many factors to be considered: increased sense of security of physicians, saving of time and travel for physicians and patients, saving of hospital days for patients, increased facility and efficiency in the group's practice, as well as unresolved questions about quality of care.

Evaluation

The Evaluator has spent most of her time observing how the system is utilized and questioning participants about their utilization. The Director of the project, although spending the great bulk of his time in patient care, seems constantly to have kept the project in mind from the standpoint of its initial objectives as well as its actual performance. Both these people base their joint tentative conclusions or their assessment of the practical values of the system. They concluded that as of December, 1973:

- "that improved care for patients will result as the services of the group specialists can be distributed throughout the health care network, that the physicians will save time and travel, and that the physicians in the distant clinic will feel less isolated."* This has not proven to be the case, except in very particular instances. The system is not often used for patient diagnosis or routine checkups which require transmitted clinical information as the sole basis for a disposition decision. The reason given is that, "The threshold of frustration at the distances involved (13 miles between Jonathan and Waconia) has not been great enough to warrant use for these purposes."** There is current speculation that the shortage of gasoline may change this, but the effect has thus far not been felt.

- Unanticipated uses, such as monitoring patients in hospital, the opportunity to engage in three-way dialogue following consultation (consultant, patient, primary physician), transfer of patient records, particularly X-rays and ECG's, and the opportunity for a physician stationed at the Jonathan Clinic to conduct rounds at the distant hospital, all are felt to have value but are extremely difficult to quantify.

- In the context of a very busy practice, the system is still regarded as "something special" requiring extra effort beyond the established routine.

- Allied health personnel tend to be more willing to initiate use of the system than physicians. Allied health personnel may suggest uses of the system. When an attending nurse at one of the clinics sees that a patient is having some difficulty in arranging an appointment, he or she may suggest the option of seeing the physician via the telemedicine link. Furthermore, nurses in the hospital may recommend the system to physicians for monitoring patients. These suggestions are a matter of some delicacy as nurses are loath to suggest to physicians how they should run their practices.

- There is no uniform appreciation among the physicians of the values perceived in the unanticipated uses which the system has facilitated.

- Significant evaluation of this system will come about in terms of the amount of money that the group is willing to pay for its continuation beyond the current funding.

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* This summary is from HCTD's abstract of contracts awarded in response to its RFP "The Use of Two-Way Visual Communication Technology in Health Care Settings."

** Personal communication, Jon Wempner, Project Director.

- Both the Director and Evaluator feel that telemedicine will not be ready for objective evaluation until long-term resources are made available, allowing adaptation of technology to the demands of various practices. Periods of critical use must be followed by modification of the technology, followed by repeated rounds of experience and adaptation.

There is no question on the part of the principals of this project that quantitative evaluations must be done. However, they perceive that the system is currently subjected to a very large number of constantly shifting variables and that comparison between system use and non-system traditional practice are currently invalid. Until telemedicine technology and users' demands on it approach a reasonable degree of normalcy, ease of function, and user-preceived reliability, it is felt that quantified evaluations will be weighted heavily against telemedicine.

8. MASSACHUSETTS GENERAL HOSPITAL/BEDFORD V.A. HOSPITAL/ LOGAN AIRPORT

This telemedicine project is widely recognized as a leader in the field. It has produced more published scholarly studies in telemedicine than all other projects combined. Its technology is diverse in capability and reliable in performance, and it has applied itself to a wide range of uses from direct patient care to training of non-medical personnel, drawing on the considerable resources of one of the nation's largest and most respected teaching medical centers. Its development is based on careful planning which has kept it constantly in a state of dynamic growth. Evidence of the preeminence of the MGH/VA system is everywhere in this report.

The MGH/VA system benefits from consistent, well-informed support by its parent institution, from relationships with other institutions of higher learning in the Boston area, as well as from long-term financial support by the Veterans' Administration, Department of Health, Education and Welfare, the Massachusetts Port Authority and others.

The MGH System's staff is unique in that its full-time Project Director is a physician. In other projects, the chief physician,who is often the Project Director, includes his telemedicine duties among other assignments, and other staff members are responsible for day-to-day operations. In the critical area of telemedicine's relationship to members of the medical profession, there may be an advantage in the constant presence and availability of a peer. On-line decisions may be influenced by the fact they are made by a physician rather than by someone responsible to a physician. In the MGH system, moreover, the Project Director is not insulated from clinical practice. He regularly sees patients at the Logan station and is frequently involved in televised transactions from both Logan and the Bedford Veterans Administration Hospital, thus "keeping in touch" with practice.

Objectives

The MGH-Bedford V.A.-Logan Airport complex exists to determine where interactive television is best employed, given the resources and limitations of the system. It aims to provide fuller utilization of the skills of health care professionals via telecommunication's capacity to deliver services quickly and reliably at a distance. In other words, its overall objectives are classical and broad.

Subsidiary objectives include:

- gathering data to encourage and implement research wherever possible
- testing interactive television not only in medical applications but for interfaces between professional medical resources and non-medical teachers and students in the educational system
- assessing requirements of users of the interactive medium and stimulating adaptations and developments in technology in response to such requirements
- facilitating better use of technology by studies which show users ways in which they can adapt to it, with minimal departure from traditional practice
- developing models by which to project cost and effectiveness of future telemedicine systems
- disseminating the information it discovers.

Planning, Training, Implementation

Planning, General

Like the other two older systems, New Hampshire/Vermont Interactive Medical Television Network and the Nebraska-V.A. Hospitals, planning activity has increased and accelerated since inception of telemedicine operations. In all three, initial planning was limited to the narrower objectives the projects were to accomplish (psychiatric evaluation/consultation in the Nebraska and New Hampshire projects, general and emergency diagnosis in the MGH-Logan project). In all three, successful experience with initial applications inevitably led to the realization that other functions could be accomplished with the operating systems, and that additional links could be built to utilize the central hospital resources on a wider scale.

Planning, Initial

The Logan Airport Medical Station-to-Massachusetts General Hospital telemedicine link was suggested by Dr. Kenneth Bird because of his desire to facilitate visualization for remote diagnosis. He was encouraged to submit a proposal for funding to HEW's Public Health Service in 1966. What follows is a précis of the proposal he developed.

Nurses, who already provided the bulk of primary care at the station, were to be chief users of the Tele-Diagnosis link and would require intensive orientation and training for participation in tele-diagnosis. Nurses would be able to contact physicians at a Diagnostic Room within the Emergency Ward of the hospital, almost three miles away at any hour. This nurse-to-physician design, which facilitates physician supervision and intervention at primary-care clinics, has since been adopted by most telemedicine systems. It thus follows the hierarchical pattern of primary care delivery in outreach clinics.

Plans were developed in consultation with the General Director of the Hospital, heads of the nursing, clinics, emergency, and medical services, the Television Committee, and many others. A large advisory board was created, representing a wide spectrum of professional and community interests. Physicians, nurses, consumers, public health administrators, health educators, social scientists, lawyers, hospital association, health insurers, educational television, and mass media representatives served on the board and participated fully in the development of operational plans. It was hoped this broad membership could help eliminate or reduce potential barriers to community acceptance.

In addition, advice and approvals were obtained from the Guggenheim Professor of Aerospace Health and Safety at Harvard University's School of Public Health who had directed the original survey leading to the establishment of the Logan Airport Medical Station, the Massachusetts Port Authority, co-sponsor of the Medical Station, the Trustees of Massachusetts General Hospital, the Chairman of the Visual Aids Committee of the Hospital, the Massachusetts Medical Society, and the Massachusetts Department of Public Health.

Endorsement by The American Medical Association and the Federal Aviation Agency of medical facilities at large airports was noted.

Studies were undertaken of electronics technology, such as telemetry of ECG's, closed-circuit television in hospital use, and already operational closed-circuit regional networks.

It was recognized that, initially, the use of physician time and skills would be inefficient until additional uses were directed to the Diagnostic Room. It was anticipated that other circuits might be developed once the feasibility of tele-diagnosis was established. Furthermore, tele-diagnosis might someday be applied to the work of the then upcoming national network of regional centers for heart disease, cancer, and stroke, and experience gained in this tele-diagnosis project could be used in similar primary care centers elsewhere in the U.S.

The plan called for an initial period of at least three years of operational development and study. Construction and installation, instruction of professional personnel, and study of control patients would take place in the first year to eighteen months. Clinical use of the circuitry and patient evaluation and study by a social scientist would begin the next year, while evaluation of selected data would take place in the final year.

Minor, differential and major complaints were anticipated in order to establish diagnostic criteria which tele-diagnosis would be expected to meet and to establish the minimal features which tele-diagnosis would have to include in order to accommodate the approximately twenty-five percent of cases requiring attention of a physician.

Procedures were established for 24-hour coverage. Staff physicians would remain in attendance at the Station week days during the 8-10 A.M., 4-6 P.M. periods of peak airline passenger travel. One of these would be the Project Coordinator who would be in direct patient attendance during the 8-10 A.M. period and, for the remainder of the day, would be able to observe tele-diagnosis activities from his office within the medical station via TV monitors. He could check unobtrusively on the performance of the system and the personnel using it, with patient safety the primary aim. Emergency ward physicians at MGH would be available 24 hours a day to the Diagnostic Room and other physicians at MGH would be on call as well. All such calls would be made via intra-hospital telephones and would utilize the hospital's paging system for physicians.

Accuracy of diagnosis would be measured by comparative studies of selected patients with known topographic or other abnormalities presented as controls or unknown patients to Diagnostic Room physicians, consultants, and/or advisors. Also stethoscopic and other findings of both pre-selected and regular patients, first examined via tele-diagnosis and later re-examined by an attending physician at the medical station, would be analyzed. Boston educational television station WGBH provided telecommunications consultation. *

A social scientist was engaged to study patient acceptance of tele-diagnosis and to help assess effectiveness of the communication and information transmission, consistent with standards of professional ethics.

Because tele-diagnosis was to facilitate the professional tasks already being done at the medical station, no additional professional staff was contemplated there, with the exception of the Project Coordinator. New staff would include the Project Coordinator (M.D.), a Diagnostic Room Physician (subsequently a number of current staff who rotated through the position), an Electronic Technician, and the Social Scientist.

Ongoing cost analysis would be determined by an automatic recorder to note time of day and duration of each transaction on the circuit. This would be correlated with both nurse and physician time to permit basic cost estimates per individual diagnostic transaction. From data thus gathered, formulae would be evolved to aid in the building of cost-effective models.

Although the medical station operates on a fee-for-service basis, no charges for actual tele-diagnosis transactions were to be levied until the technique became fully developed, at which time all applicable fees, including basic visit charges and physician consultations, plus a surcharge for use of the system would be contemplated and subjected to study.

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* Microwave path survey, system design, equipment selection, negotiation with manufacturers, assistance in obtaining Federal Communication Commission licensing of the path and frequency of the microwave transmission, screening of technician applicants, personnel training in use of equipment, and continuing assistance with experimental modifications and new developments as they evolved in actual experience with tele- diagnosis.

In addition to contemplated addition of a surcharge to basic fees, future financing was forecast in terms of institutional support by industrial compensation insurance carriers (since prompt consultation via television could reduce likelihood of hospitalization) and by insurance companies covering other physician consultation services. The carriers probably would become receptive to offering coverage only when tele-diagnosis established its bona-fides.

A comprehensive check-list for computer analysis of specific medical information was developed according to type of visit, final diagnosis, case type, disposition, transfer, acceptance of prescribed therapy, correlation of tele-diagnosis with on-site diagnosis, disagreement, patient acceptance, status on final discharge, total tele-diagnosis circuitry time, tele-diagnosis monitoring time, tele-microscopy required, observer-physician monitoring, and intervention required.

Evaluation of the quality of care would be the responsibility of the medical station and diagnostic room physicians. Provision would be made for retrospective review, by videotape, of diagnostic transactions in order to identify strengths and weaknesses in technique. It was surmised that certain physicians might be more successful than others in the use of tele-diagnosis techniques and that all could benefit from observing them in action.

The planners insisted that transmission, scanning, and audio equipment be of a very high standard of performance and reliability. They felt that nothing would be learned from using equipment which produced inferior pictures and sound or that would be out of service when needed. *

Planning, Ongoing

Growth and development of the MGH projects has been informed by an approach that considers whole-system aspects. The interactive television process is constantly assessed not only as an information-exchange, but also in terms of functions performed. This has led to study of task apportionment. Costs are assessed starting from a broad cost-accounting base and projected to systems in which telemedicine is an integral component. Studies test the limits of capacity in total-time equipment use and the ability of the telemedicine links to perform new tasks. When new technology is considered, it is categorized as having application to existing needs and services or as suggesting new opportunities, which are in turn balanced against the system's desirable growth. The systems approach has been largely fostered by the consultant CBS Laboratories has made available to MGH since early in the project's operational phase.

When a new telemedicine link with the Veterans Administration Hospital at Bedford, Massachusetts was considered, experience with the existing Logan Airport link was

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* It is pertinent that costs of some basic high-quality equipment, particularly that associated with microwave transmission, have gone down during the general inflationary period, due to improved manufacturing techniques. There are also good-quality cameras, videotape recorders and other equipment available which are better and cost less than those available in 1968.

first taken into account. The new link would be used for teaching as well as tele-consultation and would require different methods of dealing with professionals and patients at Bedford as well as a different mix of physicians and others at MGH. How could the two links be integrated without sacrificing quality at either facility and without disrupting the working structure between MGH and Logan? It was decided that a new tele-consultation studio would be added at MGH for the physicians who would consult with Bedford, plus a tele-station at Bedford, itself. Also, common services (conferences, teaching sessions, videotape viewing, etc.) would be provided to Logan and Bedford with master switching at MGH. Sharing of administrative costs would be best accomplished by a central administration at MGH. Initiation of a teaching component would require addition of larger interactive television rooms at both MGH and Bedford, as well as providing sub-links to the teaching auditoria at Shriner Burns Institute and at MGH.

Planning has perhaps benefited most from the overall systems approach to expansion of services. By assessing what the system can do, what time is available, and what are the needs of the larger community, a number of new services have been initiated.

The CBS Laboratories consultant has assisted in developing cost-effective models which allocate costs in terms of the paths that patients can be predicted to follow and the amount of television and non-television professional time patients are expected to require. On the basis of these cost-effective models further logical expansion of the telemedicine network has been projected. Plans are underway at MGH, as elsewhere, to utilize communication satellites to facilitate a regional telemedicine network.

Training

Hierarchical organizations using telemedicine, where primary care is delivered by supervised nurse clinicians, require training of nurse clinicians to perform their functions within protocols or standing orders and training for consultation via interactive television.

At Logan Airport, although nurses already were providing most of the primary care, it was decided to up-grade skills even further before beginning television transactions. An Orientation Course was designed to give all medical station nurses two weeks of specific work experience in the various intensive care units on ward and private medical, surgical, and neurology services as well as in the emergency ward and acute respiratory care unit. An additional week of orientation alternated between the Logan medical station and selected hospital patient care units depending upon the needs and desires of the individual nurse.

Following the intensive orientation, nurses were evaluated on the basis of their responses to survey forms. Upon review, the Head Nurse of the Medical Station and the Project Coordinator scheduled further in-service educational programs for individual nurses, as needed. *

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* Nurses being re-trained as primary care practitioners today, who have little or no previous experience in this type of setting, are exposed to much longer training periods than were the Logan Airport nurses.

The training for tele-diagnosis, itself, involved physicians as well as nurses and consisted of thorough familiarization with the terminology and implications in the new check-list forms used to report transactions, and thorough familiarization with the equipment. Initially, participants practiced using the equipment, on-line between the hospital and the medical station, with no patients involved. Then for a period of several months all actual tele-diagnosis patient transactions were monitored by the Project Coordinator, who could, by remote control, re-adjust camera views, lighting, and sound levels. At the close of a tele-diagnosis session, he could demonstrate to participants where they had used the equipment well or badly.

Implementation - Logan Airport Medical Station

At Logan, nurse clinicians elicit narrative histories, perform topographic physical examinations, and do appropriate laboratory studies such as white blood counts, examination of peripheral blood smears, and urinalysis. They take and describe electrocardiograms. Because they are operating in a quasi-industrial environment they have experience in management of many of the minor traumas that are seen. Therefore, relatively small numbers of patients with lacerations, contusions, and eye complaints are selected by nurse clinicians for evaluation by the tele-diagnosis physicians. By contrast, they tend to ask for consultation more often in cases of pains of the extremities, chest pains, flank pains, and sore throats. This reflects the potentially more complex differential diagnosis associated with these complaints. Although tele-diagnosis equipment was selected in anticipation of the range of differential diagnosis that would be required, no attempt has been made to equip the medical station to the extent that would be required for a highly sophisticated series of analytical procedures. The equipment is capable of presenting a wide range of information.

The tele-diagnosis system is designed to reproduce closely the normal clinical situation where doctor and patient are in the same room.* The physician is seated at a desk in the Diagnostic Room. In front of him are two television monitors, recessed below the desk top level. He can see the patient on either of the two monitors, or he can see himself. A camera placed directly in front of the physician, as close as possible to his line of sight over the top of the television monitors sends his picture to the patient at the medical station. The patient sees the physician on a large television receiver several feet in front of him. There are two cameras focused on the patient. One, directly beneath the monitor, allows the patient to appear to be looking almost directly at the physician.

Lighting in the consultation room is normal room lighting. This requires the use of a low-light-level television camera, which obviates the requirement of bright lighting usually found in television studios. The physician can control the camera into which the patient is looking, can pan and tilt the camera or zoom the lens for close-up views of the face or a particular part of the body such as an injured eye or finger. The additional camera in the airport consultation room is controlled by the nurse and this allows visualization of the patient from more than one angle. It also enables viewing of areas not easily accessible to a camera in a fixed location and permits extreme close-ups by the use of fixed focus lenses with lens extenders.

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* See Figures 1 and 2 in Chapter I. Although these photographs were taken at Bedford V.A. Hospital, the equipment is similar at Logan.

Auscultation is performed by means of an electronic stethoscope positioned by the nurse under direct vision of the physician. The patients' electrocardiogram, pulse rate and wave form, respirations and systolic blood pressure (via finger cap) can also be transmitted.

In the laboratory of the medical station, a third camera is connected directly to a binocular microscope through the use of a binocular tube and dual viewing adapter.* Four objective lenses provide magnifications of 40X, 100X, 450X, and 1000X. Simultaneous viewing of specimens directly through the eye-piece by the person operating the microscope and by the physician via television is accomplished by fixing a camera to the other tube of the dual viewing adapter.

The physician can view any one of the video outputs from the three medical station cameras by pushing corresponding buttons at the control panel. He can write orders or sign prescriptions by means of a tele-writer which is multiplexed directly onto the microwave transmission system.

Improvement in apparent resolution of the television pictures is accomplished by use of an image-enhancer. This device "speeds" transitions from light to dark to light picture elements and thus sharpens resolution. All telemedicine circuitry in the MGH system includes image enhancement.

Audio levels are set and maintained by automatic gain control in all telemedicine locations at a level which is comfortable and does not produce audio feedback.

Studies of system reliability from June, 1968 to October, 1970 produced the following projections:

Function	Mean time before failure (at 80% utilization) (Hours)	Mean time to repair (Hours)
Microwave links	1755	2.2
Video	460	1.7
Audio	1610	1.0
Control	836	0.3
Physiological monitoring	836	1.7
Total system	585	2.2

By paying close attention to probabilities extrapolated from the above data, maintenance of the system is scheduled so as to avert problems by timely replacement of parts and other preventive maintenance procedures. Planned down-time for maintenance of the system is scheduled for off-hours. Unexpected down-time from April 1970 to June 1973 was 59 hours, 40 minutes, less than 1% of total operational time. Unexpected down-time has been due chiefly to atmospheric conditions (e.g. lightning, low temperatures causing transmission drift, very heavy rainfall, and occasional heavy snow-flurries) or to human error (e.g. switch left in "off" position by technician on leave; coaxial cables not re-connected after videotape recording).

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* See Figure 8 in Chapter I.

Implementation - Bedford Veterans Administration Hospital

Professional personnel at Bedford are dealing with a different patient population and different kinds of problems from those encountered at Logan. The hospital has an average of 950 in-patients, many of whom are receiving long-term chronic care for psychiatric or neurologic disorders. Out-patients present similar disorders of lesser severity. Many suffer from problems related to narcotics habituation acquired during service in the Far East. All patients occasionally present somatic disease.

Problems referred for tele-consultation fall into either a psychiatric category or one encompassing all other specialties. The professional staff deals with a wide range of psychiatric problems and requests consultation only in certain specialized areas. Similarly, the staff deals with general medical problems at the secondary care level and requests consultation when specialists are needed. Psychiatric consultation is ordinarily requested by an attending staff physician, who is present during consultation. Medical consultations are ordinarily requested by the nurse who is Acting Director of Teleconsultations, and/or another nurse in attendance. A large proportion of cases are referred to regular tele-clinics, such as those in dermatology and speech therapy. Groups of patients interact with appropriate professionals at regularly scheduled times for psychiatric therapy, drug rehabilitation, and family problems. Tele-consultations and other transactions are conducted in a large studio-type room* in the centrally located telemedicine suite. This room is equipped in a fashion similar to the Logan installation, and possesses the same diagnostic facilities as the older one, plus X-ray viewboxes for screening films made at Bedford.

The Bedford tele-consultation link has four dimensions not found at Logan:

1. A remote-control device by which patients may see the distant physician as he is able to see them, with zoom for close or distant views, pan and tilt. This has proven particularly important in the treatment of psychiatric patients.

2. A switch which permits a wide angle view of the MGH tele-center in which the distant physician is sitting. Bedford participants can see who else is in this room, via a special camera mounted high on the wall of the tele-center. This was provided to help obviate some of the difficulties in interaction when the distant physician attends to an unseen person.

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* Figures 1 and 2 in Chapter I are photographs taken in this room.

3. A cursor, a white, moveable electronic dot, allows the distant physician to point to or outline an area of interest on the picture being sent from Bedford. Professionals at Bedford see the cursor superimposed over the picture on a large monitor. This is useful in dealing with X-rays, microscopic slides, and camera close-ups which are projecting more than can be seen with unaided vision.

4. A full-time technician, one of whose functions is to man the "nurse camera" which is outfitted with special lens adapters to provide very large close-ups. These close-ups are on the order of 10X, a degree of magnification not ordinarily available in face-to-face settings, and are used extensively in dermatological transactions.

The Bedford telemedicine suite includes a large viewing room where more than twenty hospital personnel can screen videotapes of transactions and other teaching materials or witness both ends of a transaction in progress.

The MGH end of the link with Bedford is in a large room which can accommodate as many as ten participants, in order to facilitate interactions when there are multiple consultants or multiple psychiatric residents, who are then able to observe and interact with a wider variety of patients than they ordinarily see at MGH. This tele-center is equipped like the Diagnostic Room at the Logan link and it has the aforementioned cursor.

Utilization - Logan Airport Medical Station

Since its inception, more than 5,000 tele-diagnosis transactions have been accomplished, each fully documented by nurse clinicians and consultants. The number of transactions does not represent maximum utilization of the link. During the more than five years in which the link has been operational, the medical station has served over 70,000 patients. Were there no physicians in attendance at the station during peak periods, the number of patients for whom consultation would have been sought might well have been upward of 15,000.

The Logan tele-diagnosis and Bedford tele-consultation systems are still regarded as experimental. Although they have met with considerable approval at MGH and elsewhere, the projects remain subject to evaluation. Consequently, maximum utilization will not be achieved until telemedicine has proven able to: meet cost-effective standards, which are not yet clearly or universally understood; deliver health care and other services at a consistent high standard of quality; and provide access to its facilities in time and place, consistent with the rights and expectations of professionals and consumers.

The Logan-MGH link currently is not cost-effective because it does not approach maximum utilization of the tele-consultation mode. Although records of over 5,000 televised patient transactions and observer-evaluations of their disposition show standards consistent with high quality care, the bulk of consultation remains in the hands of physicians in attendance at the Logan medical station. Cost-effectiveness would be achieved, according to internal calculations, if attending physicians were not present, and all consultations were handled via the telemedicine link. Access to the facility is not limited in any way and an early study showed a high level of patient acceptance.

The Logan-MGH telemedicine link remains in the experimental category, since a decision has not been made to change its status to an entity where approximately 90% of required consultations are provided via interactive television. Hesitation to recommend or take such a decision is understandable. Telemedicine is not yet widely understood, much less accepted by the great majority of the medical establishment. It is regarded by most as in its infant experimental stage, at best, and as a suspect aberration at worst. Even most telemedicine practitioners regard the concept as experimental, its many apparent benefits and successes notwithstanding.

In the meantime, utlization of the Logan-MGH link has been broadened by the inclusion of medical and paramedical activities which involve segments of the population other than airport employees or air travelers.

- A study was conducted at the Logan Station of the effects of airport noise on hearing in children living nearby.
- Evaluation of learning disabilities in students from the Malden-Melrose School System was accomplished via the telemedicine link, using expert consultants at MGH.
- As a follow-up to the above evaluations, 385 teachers in the Malden-Melrose School System were instructed in ways to be on the alert for learning disabilities in students, many of whom exhibit behavior problems and are thought to be poorly motivated or suffering from seeing or hearing loss. This instruction utilized the Bedford V.A. link
- A specialist from MGH has presented two courses to teachers at the Logan facility on counseling adolescents.

Utilization - Bedford Veterans Administration Hospital

Although consultations may be called for at any time from Bedford, the bulk of complaints from this location are treated on a regularly scheduled basis. Reference to the MGH-Bedford sample weekly schedule (see Appendix A) indicates the scope of utilization for consultation in medicine and psychiatry as well as therapy in psychiatric and family problems. From July, 1969 to July, 1973 there had been 2,641 telemedicine transactions between Mass. General and Bedford. Between March, 1970 and May, 1973 the telemedicine transactions involved 5,350 patient encounters and 6,456 staff encounters. These large numbers of encounters reflect the many occasions where groups of patients and members of staff are involved, either in therapy and/or consultation as well as in educational and conference modes. The Bedford link is further utilized, as is the Logan link, for service to the community. Courses in health-related subjects are taught by professionals at MGH to students of the community college at Bedford which occupies hospital buildings no longer needed for care of chronic mental patients. In 1974, physicians at MGH are to begin a series of teaching demonstrations, using MGH patients, for continuing education of physicians at Bedford.

Evaluation

Evaluation was made by physicians of the first 200 patient transactions from Logan as to feasibility of arriving at reasonable disposition of cases. These evaluations reflect not only the capacity of the telemedicine link, but also the standards of physicians working within the context of a teaching hospital. These standards may not be universally relevant. Both the physician making the disposition via television and the physician directly observing transactions through a one-way mirror participated in the evaluation. In response to the question: "Was it feasible to arrive at a reasonable disposition?" the results were:

	Telediagnosis Physician	Direct Observer
Feasible	64.5%	96.5%
Minor Reservations	30.0%	1.5%
Major Reservations	4.0%	1.0%
Not Feasible	1.5%	1.0%

Disagreement as to minor reservations may reflect the telediagnosis physician's personal feelings during transactions and the direct observer's disinterested, non-involved state. In any event, given these minor reservations, both concluded feasibility at better than 94%.

Internal evaluation of transactions has been ongoing since 1968, often utilizing the videotapes of those transactions. These have served as bases for discussing improvement of techniques in televised practice modes.

9. MOUNT SINAI-WAGNER BI-DIRECTIONAL CABLE LINK

Mt. Sinai-Wagner's short, 1.5 mile telemedicine link in New York City was provided free of charge by the TelePrompTer Corporation, the local cable franchise holder. Television and sound equipment were purchased by the project. Should there be additional demand for health service in Mount Sinai's service area it is conceivable that branches could be added to the now-existing cable.

The child health station at Wagner Houses serves approximately 1300 children in the local health district, which is in a predominantly Hispanic low-income neighborhood. City-employed physicians pay regular visits to the clinic, but until the telemedicine link became operational, referral for pediatric and other consultations presented difficulties. Presence of a full-time pediatrician on-site was not warranted by the small population served, thus consultations required going to the Mount Sinai Medical Center. Many parents of patients were unwilling to go to the huge, unfamiliar center and very often did not keep appointments. The telemedicine link has alleviated many of these problems.

Objectives

The major objectives of this project are to:

- Determine whether the technology of bi-directional cable television will be accepted by both health providers and consumers.
- Determine whether or not the bi-directional video and audio contact can be used effectively and efficiently in lieu of in-person physician/patient contact.
- Determine whether such use can be cost beneficial.

Planning, Training, Implementation

Planning

Although the purpose of this cable link was to give health workers at the clinic access to the co-directors at times when they would not normally be present, it was feared that. with the link's establishment, the clinic's co-directors simply would not be present at the clinic any longer. This became the case. It was then decided that emphasis would have to be placed on two-way television's providing greater access to the co-directors, and access to a wider variety of specialists than previously.

Meetings and demonstrations of the equipment both for professional staff and for parents of patients concentrated on promoting the improved communication with Mount Sinai that would be facilitated by the telemedicine link.

Technical equipment was tested both for its capacity and its demands on users, prior to the system's becoming operational. Thoughtful observation led to some changes in use prior to operation. It was found there was a tendency to use the television consoles from a sitting rather than a standing position which led to redesigning the consoles, while casters for the console at Mount Sinai allowed it to be used at either of the co-director's desks. The omni-directional microphones were found to pick up excessive amounts of ambient noise, so they were replaced with uni-directional microphones. The 25mm lens provided at the clinic would not suffice for covering staff meetings or for close-ups of patients and was replaced by an 18mm to 90mm zoom lens that covers both contingencies. Several variations of lighting systems were tested in terms of excessive heat and light as well as esthetic considerations.

The Project Director had considerable prior experience in telecommunications and his experience is reflected in maximum value of equipment for funds expended, optimal design configuration, and assurances of maintenance by equipment dealers as a condition of purchase. Although the link is operational, adaptations of technology to use and adaptations of use to technology continue to be made within the constraints of budget and available time.

Training

It is probably accurate to say that some training and learning occurred outside any formal training sessions. The clinic staff and the clinic co-directors were kept informed of the progress being made in building the link. Some staff members attended demonstrations of closed-circuit television equipment and considerations of changes during the planning process added an informal training/learning dimension.

Formal training in this project was accomplished as follows: *

"At first only the clinic co-directors and the one male community health worker were taught how to use the system. This was done intentionally. While it was hoped that every staff member would eventually learn how to use the system, the project staff did not want the clinic staff to feel that they were being burdened with an additional task. The decision was made to wait until the clinic staff asked to be instructed in using the system."

"This occurred within two weeks after the installation. One of the practical nurses on the clinic staff complained to the associate project director that it was not fair that only the male community health worker knew how to operate the system. She later repeated the complaint to the project director over the cable. After some good-natured humoring, the project director assured her that everyone who desired to learn how to operate the system could do so."

"Shortly thereafter, a meeting with the clinic staff was held for just that purpose. The associate project director taught the staff how to turn the system on and off, and make simple video and audio adjustments. Particular emphasis was placed on which adjustments to make to insure their own privacy, a matter on which the community health workers frequently voiced concern."

During the early days of operation the Associate Project Director was constantly present to insure that personnel could operate the system. As difficulties of operation arose, the associate project director was available to help.

Implementation

As originally conceived, this link, though user-operated, did not provide for remote control of cameras. It always has had considerable flexibility in the number of clinic locations from which patient care transactions could be initiated. Remote control of the camera at the clinic became necessary when psychiatric consultations were begun, in order to insure privacy of doctor-patient sessions, since without remote control someone else would have to be present in order to focus and adjust field of view. Cameras and micriphones of adequate capacity plus a cable transmission dedicated solely to the telemedicine link insure a reasonable standard of picture and sound fidelity.

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* Quoted from mid-year report of Contract HSM-72-382, written by the principal investigator and project director and dated February 8, 1973.

Utilization

To encourage utilization throughout the clinic on an elective rather than prescribed basis, and to discover what particular problems might be generated in different clinic locations, the camera cart at the clinic was moved from day to day, and sometimes several times during the course of a day.

There has been much informal use of the system which participants believe has been helpful in gaining acceptance for it. For example, when the camera cart at the clinic is in the waiting room as it often is, mothers, recognizing one of the clinic's co-directors on the TV screen, may call attention to her child by holding the child up to the camera and simply having a brief contact with the co-director at Mt. Sinai.

It has been the custom to leave the equipment at the clinic "on" throughout ordinary working days. This has increased utilization but also makes it difficult if not impossible to log every activity. When either of the clinic co-directors is contacted informally, as above, these transactions have not been logged in the past and probably will not be. To log some transactions would require more time than the transactions themselves.

Formal use of the system enables psychiatric social workers, psychiatrists, orthopedists, and social workers to handle situations at the Wagner Child Health Station without having to take the time to travel there.

It is observed that both children and their parents, usually the mother, are very accepting of the telemedicine link. An interesting phenomenon has appeared in this setting, which raises some questions about the childrens' perceptions. For example, two children who never spoke to the nurse co-director during two years of frequent face-to-face visits at the Clinic became very talkative when they saw her on television. The principal investigator and project director speculate about what may be operative:

> "1. The child is probably very familiar with television, and views any occurrence on the screen as entertainment."
>
> "2. A nurse is less threatening on television. She cannot, for instance, give an injection over the television!"

The two principals go on, "It would be important to determine whether, in such a case, the child realizes that the nurse at the clinic and the nurse on the television screen are the same person. It should be noted whether or not the child speaks to the nurse on subsequent in-person visits at the clinic, or whether the child maintains the distinction between the in-person individual and the television individual."*

Anticipated uses of the system have tended to operate in a manner quite consistent with expectations. The system is used for consultation with qualified professionals at Mount Sinai about problems arising in a primary care pediatric clinic.

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* Ibid.

Unanticipated uses of the system, as in the case of most telemedicine situations, have been added dividends. Principals of the Mount Sinai-Wagner system have begun to use it in the training of new nurse practitioners. The camera cart can be placed with the trainee in her examining room and her work can be observed by one or both of the co-directors. Such sessions are conducted in a manner that avoids "looking over the shoulder. Rather, they are regarded as opportunities to discuss practice particulars in terms of actual patient examination.

The system has been used as a means of discouraging visitors whose presence at the clinic disrupts routine. Visitors are now taken to the co-directors' office and can observe clinic functions via the bi-directional television.

Administrative matters are increasingly handled via the television link. It is often easier to come within camera range and establish contact, than it is to go through the hospital switchboard with a telephone call.

Perhaps because the telemedicine link is readily available at any point in the clinic and because all clinic personnel are free to use it, this system appears to have become a fairly normalized and routine operational mode, even though it is still experimental.

Evaluation

The objectives of the project are essentially evaluation objectives. The project principals note that the objectives are sequential—that one cannot be considered until the previous objective is successfully accomplished. In order to determine whether or not the bi-directional video and audio contact can be used effectively and efficiently (Objective #2), one must first determine that the technology of bi-directional cable television is acceptable to both health providers and consumers (Objective #1). To determine whether use of the bi-directional video and audio can be cost beneficial (Objective #3), it must have been determined that the system can be used effectively and efficiently in lieu of in-person physician/patient contact (Objective #2).

Cost benefit will be evaluated in terms of: change in staff/patient ratio; lessening need for return visits; and reduced proportion of serious illness requiring intensive work-up, hospitalization and after-care.

At the conclusion of the project, the total clinic cost will be determined and measured against the total number of patient visits by condition. Assuming the quality of care will remain constant or improve, the cost per clinic visit for provider time can be determined and compared with the year prior to installation of the cable.

Principals of this system note:* "The additional cost to the clinic operation will be that of establishing and maintaining the cable link. Although this may not be cost-effective in terms of one child health station, meaningful cost-effectiveness could be projected to the establishment of three or more such links."

"The evaluation procedure established for the first year of operation may be extended to subsequent years, perhaps with modification, based upon experience."

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* Ibid.

The principals also feel they are succeeding in making specialist consults available and useful where before they were largely unavailable, or if available at the medical center, not sought. They note, in reference to the monthly orthopedic tele-clinics, that:

- the orthopedist does not have to use time in travel to or from the clinic, and travel/waiting time for patients is less than would be involved in going to the medical center;
- the orthopedist can screen patients for further referral, to the medical center; and
- after these screenings, parents are much more likely to keep referral appointments because they have "met" the specialist when he or she examined their children via television.

10. NEBRASKA VETERANS ADMINISTRATION NETWORK

This project grew directly from the pioneering experiments in telemedicine between University of Nebraska Medical Center (UNMC) and Nebraska Psychiatric Institute (NPI) and subsequent links between those two institutions and Norfolk State Hospital.

Beginning in 1969 the Veterans Administration provided a grant to UNMC which has supported the University's costs involved in its participation in the Nebraska V.A. Network. Six Nebraska institutions are now interlinked by the network. The Omaha Veterans Administration Hospital is the control point for switching among the other locations, which include Grand Island Veterans Administration Hospital (127 miles from Omaha), Lincoln Veterans Administration Hospital (60 miles), University of Nebraska Medical Center in Omaha, Nebraska Psychiatric Institute in Omaha, and Criss Institute for Health in Omaha, which is affiliated with Creighton University School of Medicine.

Objectives

Initial objectives were stated as early as 1962, when local representatives of the Omaha Veterans Administration Hospital (OVAH) and the Director of the Nebraska Psychiatric Institute began their long campaign to incorporate telemedicine between the V.A. hospital and NPI (the Department of Psychiatry) at the University of Nebraska College of Medicine. Those objectives were:

- To install a two-way closed-circuit TV system with video-tape recording capabilities in order to facilitate closer collaboration between institutions.
- To integrate the Neurological and Psychiatric Services of OVAH and the Psychiatric teaching and clinical resources of NPI for cooperative teaching, clinical services, and research programs.

- To develop and demonstrate the use of modern communicative techniques as a means of extending a Medical Center capability to remote institutions.

As time has gone on other objectives have been added:

- To provide education for professional staffs of the VA hospitals at all levels.
- To provide consultation in psychiatry and medicine to VA hospitals which are remote from medical teaching centers.
- To organize programs in group therapy, vocational rehabilitation, and alcoholism therapy for VA patients.
- To provide significant educational services to University students while they receive training as care providers at the VA hospitals.
- To provide non-medical education for other staff.
- To provide utilization of two-way facilities for other educational programs, utilizing the resources of the Universities as well as the VA.

Planning, Training, Implementation

Planning

Very little material has survived to tell what plans were formed between 1962 and 1969, when the Nebraska VA system became operational. It is apparent, however, that close liaison was maintained through those years between the VA and Cecil Wittson and Reba Benschoter of the University of Nebraska Medical Center.

In December, 1969, interconnections between the three VA hospitals, UNMC, and NPI were approved by the VA.

Veterans Administration evaluation forms filed a year after the system became operational show that -

- equipment had been purchased and installed with an eye to providing video and audio signals of very high quality.
- initial operations at Omaha included transmission from two locations in the VA Hospital, with reception at those two locations plus six others.
- acquisition of the OVAH telemedicine facility including all hardware, connections, and installation was completed.
- initial staff at OVAH consisted of the chief of the television service and two operating assistants.
- percentages of time devoted to education were 68%, patient care 25%, and miscellaneous meetings 7%.

Training

Training was limited to the relatively few persons who operate controls and cameras within the system.

Implementation

Grand Island and Lincoln Veterans Hospitals have one bi-directional studio each, as opposed to the two at Omaha. All locations have added flexibility for transmission and reception of transactions with movable carts carrying video monitors, speakers, and videotape recorders; together with movable cameras, these facilities allow transmission/reception from points in the hospitals distant from the studio spaces.

Color capability recently has been added to the facilities at Lincoln. The Criss Institute for Health is also equipped for color.

Utilization

Reference to the schedule (See Appendix A) will give an overview of the way in which use is distributed throughout a typical five-day week, with activity beginning every day at 8 a.m. and continuing until 2 to 10 p.m. It should be noted that hours which appear unscheduled are frequently used for consultations and other activities arising on an ad hoc basis.

The following descriptions will give a somewhat fuller picture of various types of scheduled and unscheduled activity.

Interactions between Nebraska Psychiatric Institute and VA Hospitals

- The Director of the NPI Alcoholic and Drug Abuse services along with other therapists and psychiatric residents conducts several therapy and consultation activities via the system. Alcoholic patients at Omaha VAH participate in weekly group therapy meetings of 10-15 patients. 90-minute sessions start with videotapes of the previous meeting to allow both patients and therapists to observe their own progress. Therapeutic sessions range from support to dynamic psychotherapeutic insights, depending on the therapists' orientation.

- NPI alcoholism treatment programs with the Lincoln VAH occur bi-weekly with both individual and group therapy sessions.

- NPI gives individual outpatient psychotherapy to patients at Grand Island VAH. Informational sessions are held with physicians at Grand Island so that they can follow up these cases.

- NPI conducted a series of 82 televised interviews with 27 Omaha VAH patients in a vocational rehabilitation program. Interviews were done by counselor interns. Later,counselors supplemented these interviews with face-to-face meetings.

- NPI makes regular presentations on alcoholism problems to social workers and medical-dental staff at Grand Island VAH.
- NPI psychiatrists supervise, via TV, the psychiatric residents who are placed at the Omaha VAH.
- NPI pre-doctoral psychology interns in training do service at Omaha VAH and are supervised by NPI MD's and Ph. D.'s.
- NPI Grand Rounds are transmitted to all VAH's, as are NPI visiting lecturers in psychiatry, social work, law, nursing and communication.

Interactions between University of Nebraska Medical Center (UNMC) and VA Hospitals

- Junior and senior medical students from the University of Nebraska who provide service at the Omaha VAH meet 4 times per week via telemedicine to discuss internal medicine problems with University of Nebraska instructors. The students study assigned material before meetings.
- Lecture series for junior and senior medical students assigned to Omaha VAH. Weekly EKG conference, DEMGO conferences (Diabetes, endocrinology, metabolism, gastroenterology, oncology), CHIP conferences (Cardiology, hematology, infectious disease, pulmonary.)
- Weekly hematology conferences for medical students from U. of N. and Creighton and house staff of Omaha VAH are given by staff from University of Nebraska, Creighton, and VAH.

Nurse and paramedical interaction

- Periodic conferences are held at all institutions on surgical nursing.
- Nurses at all institutions who are responsible for staff development and administration hold monthly meetings to plan programs for nursing staff and paraprofessionals.
- The nursing staffs hold monthly meetings to view and discuss training videotapes.
- Social workers hold monthly meetings to view and discuss training videotapes.
- Physical therapists and PT students from UNMC attend monthly programs in continuing education.

Other professional interactions

- Grand Island has neither a nuclear medicine specialist nor psychiatrist, and scans are read and psychiatric consultation is provided from Omaha VAH.

- Regular all-institution conferences discuss specific issues in pulmonary disease, general pathology, neuropathology, clinical pathology, surgical pathology, general surgery, neurology, cardiovascular disease, and medical administration.
- The Tumor Board from all institutions meets regularly.

Other interactions

- Clerical workers participate in a regular 10-week course to improve their skills and discuss brief forms and medical terminology.
- Closed-circuit TV coordinators meet monthly.

Evaluation

A V.A. progress report of July 1972 states: "Informal evaluation of specific uses has yielded positive results. Perhaps the best testimony to the effectiveness of the system is its steadily increasing utilization."*

In the 1972 progress report one notes that of 560 patients who had been through alcoholic group therapy, those who had at least three months of TV therapy and been out of the hospital at least six months, showed a 70% abstinence level. Patients commented that the TV groups were one of the more positive aspects in their treatment.

Also, nursing staff development directors found telemedicine "advantageous in reaching more nurses than would have been possible with single-hospital presentations." They also commented on the benefits from working with persons in different institutions.

Observations by supervisors of intern counselors doing vocational rehabilitation showed that counselor-client relationships develop at least as quickly via telemedicine as face-to-face.

Finally, interns and residents have more time for patient care because classes and supervisory conferences are provided where they work and they no longer need to travel between the participating institutions.

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* In a discussion in early 1974 with Robert Shamaskin, Chief, Systems and Technology Division, Learning Resources Service, in the V.A.'s Dept. of Medicine and Surgery, he pointed out that the V.A.'s policies on evaluation are focused on costs and benefits of delivery and the effects on patient care. The V.A.'s huge patient population makes possible assessment of short and long term effects.

11. NEW HAMPSHIRE/VERMONT INTERACTIVE MEDICAL TELEVISION NETWORK ("INTERACT")

"Interact" is the network that has developed from the 1968 link between the Dartmouth Medical Center in Hanover, N.H. and Claremont General Hospital at Claremont, N.H. By October of 1972, the network included the University of Vermont Medical Center at Burlington and the Central Vermont Medical Center at Barre, while links to additional institutions were imminent, since optimal utilization of resources required extension of the network to a wider base of secondary and primary care institutions. This microwave network is the largest telemedicine project providing health services to small towns and rural areas and is unique in linking resources of two widely separated medical school hospital centers.

Objectives

This large, pioneering network has several objectives covering a wide range of medical services and professional education. In establishing the first link between Dartmouth and Claremont three specific objectives were identified to demonstrate:

1. The potential of interactive television and telemetry to provide continuing education to physicians and allied health workers;

2. The efficacy of sharing faculty between institutions concerned with health manpower training; and

3. The feasibility of providing selected health care services which may not be universally available.

As participants gained experience, potential uses were derived from careful analysis of needs expressed by members of the Claremont staff, community health workers and health educators from Claremont and surrounding communities. These were matched with resources available at the Dartmouth-Hitchcock Medical Center, with special consideration given to existing programs.

1. Psychiatric consultations, which had already generated widespread support;

2. Development of medical center support for a cancer clinic held regularly by the Claremont staff;

3. On-going specialty conferences conducted daily from the medical center;

4. Coronary care conferences for nurse-to-nurse and nurse-to-physician consultation, and for transmission of ECG's using rented data phones;

5. Emergency medical care work conferences for ambulance and other personnel involved in emergency care;

6. Social service conferences which could help fill a void in the Claremont area;

7. Speech therapy service, previously unavailable to the Claremont community;
8. Pharmacology course for nurse practitioners with students at the Mary Hitchcock (Dartmouth) Hospital, Claremont Hospital and the N.H. Vocational Technical College, Claremont, as the links become available.

Interact's broader goals were developed through the establishment of the newer links from Burlington and Barre, Vt. to the older Dartmouth-Claremont link. These goals are:

1. To create a system using technology in which community health workers may cooperate in continuing education opportunities;
2. To use the system to develop and establish new manpower training facilities; and
3. To provide new services in the community hospital settings.

In November, 1973, the network expanded to include the State Prison at Windsor, Vt., a community hospital at Bellows Falls, Vt., and a state vocational/technical school at Claremont, N.H. Each institution brings to the network a different population mix, with different needs in patient care and different contributions to the learning experiences. One assumption underlying such proliferation is that health services and training can be made available by interactive television in almost any setting where the population needs and desires such services.

The Dartmouth co-director has made it clear that the Interact Network must become increasingly self-supporting. Enlistment of additional network participants who have sufficient reason to help defray costs is a major current goal. It is indicative of much current experience, which goes beyond feasibility studies and experimentation for their own sakes, when survival of a system becomes the ultimate objective in order to provide health services.

Planning, Training, Implementation

Planning activity is consolidated in the offices of the Directors of Research and Operations. Broad plan guidelines were drawn in 1970 following a study by an independent research organization. The basic plans called for addition of the new locations noted and emphasized a widening base for health services, professional and paraprofessional training. Lack of funds, however, has made it difficult to proceed with the plan on a priority-determined schedule.

The master plan for potential expansion which was developed in 1970 is based on these assumptions:

- that nationwide efforts, guided in part by comprehensive health planners and initiatives in health and social services at federal and state levels, will strengthen the roles of community hospitals and other community health and welfare services.

- that community institutions cannot effectively expand their roles or develop prerequisite educational programs for their staffs without communication links to larger centers.

- that projects like Interact demonstrate they can, by providing needed biomedical communications, catalyze the small community hospital as a focus for educational and community services.

- that there is a need, emphasized by the Carnegie Commission report, for educational institutions to share their know-how and to develop coordinated programs in community settings. ("Area Wide Health Education Centers" or "Community-Based Manpower Programs.")

- that in many rural areas a consortium of educational institutions serving a locus of community-based training programs would not be practical because of necessary relocation of faculty or students. However, an effective consortium of education institutions can be established via a biomedical communications network.

- that broad expansion of medical service via television demands a level of technical reliability and of physician acceptance. The latter comes relatively slowly as controlled experiments prove that telemedicine meets exacting requirements. Those closely involved with the N.H./Vt. network have reaffirmed the validity of these assumptions, and would add:

- that communications technology needs to be adapted to medical use in ways that optimize technological capability, and that health care professionals need training to understand what the technology can do, so that they can aid in the technology's design.

- that professional users' insistence on developing technology only to replicate traditional functions is counter-productive and inhibits innovations that may arise from factors inherent to the medium.

- that the potentials for utilization of telemedicine at the professional/technology interface are in a pioneering stage, and will require long-range support if they are to be realized and fairly assessed.

Training

Training is informal, consisting of suggestions on specific additional applications relevant to the user's interest, critiques of user employment of the medium, and solicitation of user comments about the system's ability to do what users want it to.

Implementation

The Dartmouth co-director, in particular, has resisted inclusion of "canned" videotapes and films on the network, in order to underline the interactive, two-way capability of the system and to encourage exploration of it.* He feels that pre-produced materials tend to be one-way communications not structured for interaction. Consequently, educational programs as well as patient sessions are "live," and learners are encouraged to question and comment, making the experience responsive to their interests and needs. Exploration of the medium comes about as users, both at the medical centers and the community hospitals, are challenged to show rather than merely tell what it is they wish to convey. In showing they are forced to confront the system's capabilities.

This system has been operated almost totally by technicians, necessitating their physical presence during most interactions. This is felt to be often counter-productive. The presence of a technician produces some distraction. Furthermore, since technicians must turn the system on, often set up equipment, man cameras and adjust microphones, etc., physicians tend to "think twice" before setting such activity in motion and are reluctant to use the equipment freely. Users often must explain beforehand or speak directly to the technician in order to adjust a camera view or move to another view during a transaction, which can be time consuming. Finally, users have so little actual contact with the equipment, their understanding of its operation and capabilities is inhibited. However, experience with the system in the "psychiatric/emergency" mode after-hours has shown that physicians can turn on the equipment at Dartmouth and be in voice/visual contact with Claremont. They can indeed use the equipment productively and not damage it. Steps are now being taken to give users remote controls of distant cameras so as to be able to use the system with less-elaborate preparation and without reliance on technicians.

Acceptance of contracts from HCTD to experiment with speech therapy and dermatology diagnosis/consultation has led to the addition of paraprofessionals who execute certain functions under the supervision of a distant dermatologist or professional speech therapist.

Utilization Experience

A typical week's schedule (Appendix A) shows some of the network activities that are concerned with the unmet needs of a predominantly rural area where distance is an important factor in delivering health services and professional education.

An important lesson was learned from experience with the original Dartmouth-Claremont link. It was found that the location of telemedicine facilities was important to utilization, particularly in the initial stages, and facilities were placed where professionals expected they would be in terms of traditional practice behavior or status needs. But once the system had gained acceptance, tele-stations could be located so as to take advantage of the most convenient available space.

Informality has been an influential factor in bringing together community and teaching hospital medical staffs. One such informal event, usually scheduled weekly, is simply called "Breakfast with Dr. Almy." This brings the Chief of Medicine at Hitchcock Memorial Hospital together with most of the medical staff of the Claremont Hospital, who find it a pleasant setting in which to discuss a wide range of topics of interest, from purely practical ones to questions about the latest medical developments.

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* An exception is made, however, in regular showing of programs distributed by the Network for Continuing Medical Education.

Utilization correlates fairly closely with the degree to which professionals at network locations have come to know each other via the interactive medium and to shed whatever misgivings they may have felt about dealing with previously little-known or unknown colleagues.

The addition of three locations in November, 1973 (Rockingham Memorial Hospital, Bellows Falls, Vt., Windsor State Prison, Windsor, Vt., New Hampshire Vocational Technical College, Claremont, New Hampshire) made Interact the largest of the telemedicine networks in terms of number of institutions served. The reason behind expansion was to create wider utilization of the resources of the two medical school teaching centers and to facilitate a new kind of teleconferencing. Both the hospital at Bellows Falls and the Windsor Prison were expected to benefit from opportunities for medical consultation and, as in the earlier links, opportunities for staff training were anticipated at Bellows Falls. Students at the vocational technical college could enroll in health services courses, the first of which was in pharmacy training. In addition, two fifteen-week credit courses were offered from the vocational technical college to the four full-time locations and Bellows Falls. For this course, the college instructors used the permanent facility at Claremont General Hospital and the mobile van (see below) enabled participation at Bellows Falls. The courses, which began in February, 1974, were sign language for the Deaf and Medical Ethics. A non-health care function was facilitated at Windsor Prison: televised meetings of the State Parole Board, at the prison, at a telemedicine studio in the University of Vermont Medical Center at Burlington, and at the Central Vermont Medical Center in Berlin. (Berlin is convenient to Montpelier, the capitol of Vermont, and to Barre).

The three newer locations in Interact were brought into the network on a part-time basis. All are served by a single mobile van which carries transmission and reception equipment on a regular circuit of the three. On Mondays, Tuesdays, and Wednesdays, the van is at Bellows Falls. On Monday and Wednesday evenings it serves the vocational technical college in Claremont. On Thursdays it brings its equipment to the Windsor State Prison.

Evaluation

Principals in this system are convinced that any evaluation, which attempts to quantify a communications mode operating below optimal technological capacity and at a fairly low level of user understanding, cannot properly be made. They believe that the currently-popular yardsticks of cost-effectiveness and cost-benefit are impossible to apply in any manner that will yield useful data. On the other hand, there is subjective evidence that the system is accepted by providers and patients, teachers and learners.

Speech evaluation and therapy was provided by an HCTD grant (1972-1973) to 25 children, aged 4-11, over a period of several months. The therapist was at the University of Vermont Medical Center, in Burlington. The children were all pupils of a parochial school in Claremont, N.H. which provided transportation from the school to the community hospital in Claremont.

The experiment hypothesized that: the therapist could successfully evaluate speech problems as well as learning difficulties; the therapist could do significant training of the patients; an aide with the patient would be both useful and acceptable; and both patients and their parents would accept this form of contact. Parents were invited to sit in at the sessions, so as to gain insight and direction for working with their children at home. Sixty-eight individual therapy sessions were conducted. In the opinion of the therapist, all hypotheses were satisfactorily validated.

Interviews with nine of the parents revealed: all felt the experience was as satisfactory as an "in-person" one would have been and none felt his or her child was intimidated in any way; one felt her child showed less shyness than would have been the case in a face-to-face transaction; and if the television therapy had not been available, four parents would have been unable to get any help, two would have tried to help the child themselves, two were prepared to seek professional help elsewhere, and one didn't know what she would have done.

At the beginning of the 1973-1974 school year, the Claremont public school system, which had closely observed the speech project, committed its entire current budget for speech therapy ($2,000) to this mode. The network accepted the commitment, although the service will cost more than the schools' contribution.

Dermatology clinics were also provided by the 1972-1973 HCTD grant. In this case color television equipment was utilized. The demonstration experiment was approached in phases. While the dermatologist was gaining some experience with the television equipment, she held some tele-clinics at Claremont Hospital, first seeing the patients from another room on television, then in person to verify and confirm her diagnoses. During this time she was also training a Medex to work as an aide in dermatology. The dermatologist used both color and black-and-white television during this first phase. When the experiment moved into its Claremont-to-Dartmouth phase,* the Medex stayed at Claremont, presenting patients and performing whatever tasks were required by the dermatologist.

This experiment sought to answer the questions:

- Could the dermatologist successfully control diagnostic/therapy sessions via the interactive medium?
- Would lesions be sufficiently discernible?

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* 125 different patients were observed in 258 individual sessions during 31 clinics held over a period of ten months. Patients ranged in age from 4 months to 89 years (Mean 36); 83 female, 42 male. 114 of the patients were referred by physicians (GPs-78, Internists-15, other Specialists-21.)

- Did color television enhance the sessions?

- Would patients accept a) the presence of the physician on TV and b) the presence of the paraprofessional on-site?

During the experiment, the dermatologist graded the first three questions above on a scale from 1 to 5 (5 most positive) and her scores averaged well toward the high end for all three questions during the whole period. She felt that color made diagnosis easier and faster and less stressful, although not necessarily more accurate than black-and-white. The dermatologist was highly satisfied with the system.

In response to acceptance of physician-by-television and the presence of the Medex, all 37 patients queried were positive, with most rating acceptance at the top of the scale.

Further questioned as to what they would have done about their skin problems had not the opportunity presented itself to be seen over television, a third would have traveled the 30 miles to see a dermatologist at Dartmouth, a third would have consulted their family physicians, and a third would have done nothing.

Claremont Hospital has agreed to support the Medex and to handle all administrative details in connection with an ongoing regular dermatology telemedicine clinic, but support for consultant fees and overhead must come from some other source.

12. RURAL HEALTH ASSOCIATES: INTERACTIVE MEDICAL MICROWAVE TELEVISION

Rural Health Associates, a private group medical practice, was the first medical care organization to include interactive television communications as an integral aspect of the organization at the time of its founding. The group is based on Farmington, Maine, adjacent to Franklin County Memorial Hospital, a well-equipped 50-bed general community facility. Ambulatory-care satellite clinics in Rangeley (40 miles north) and Kingfield (20 miles north) are linked to Farmington by microwave transmission. A third satellite clinic at Jay-Livermore Falls (20 miles to the south of Farmington) was not a part of the television system at time of writing, thus two physicians are required to be there full-time.

In aiming to deliver comprehensive health care to the area, this group views its communication capacity as indispensable. Two-way telecommunication is used not only for patient care, but for the wide range of communications which all members of the group require in order to perform as a single functioning unit.

One of the group's founders, Dr. David Dixon, feels the group would have an entirely different character without interactive television. "We would be just four separate, isolated clinics," he says. "But with the television we are able to stay in close contact."

The full-time staffs at Rangeley and Kingfield satellite clinics consist of nurse associates and medexes, and physician consultation is supplied via television most of the time. Many of the group's members do rotate through these clinics but only one-half day a week.

Objectives

- To make ambulatory care available in a rural area where such service was minimal to non-existent.
- To give professional health care providers the support they need to be able to live and function in rural areas at a distance from major medical centers.
- To provide sufficient coverage so that health care professionals can afford the time to engage in continuing education, to develop and broaden their special areas of professional interest and to "catch up" on the residue of health problems so that some attention can be paid to preventive care.

Planning, Training, Implementation

Planning

Almost one quarter of the 30,000 people living in West Central Maine must get along on incomes below the poverty level, and more than half live in families with incomes of less than $5,000 a year. Against this dismal economic background, Rural Health Associates obtained grants from the Office of Economic Opportunity of approximately two million dollars (July 1, 1971-April, 1974) as start-up funding to provide medical and dental services to these people. For the poor in the area, Rural Health Associates is a prepaid Health Maintenance Organization (HMO) which OEO underwrites at a cost of about $150 per patient per year. RHA performs fee-for-service for patients who can pay the modest fees of $7.00 for the first visit and $5.00 for subsequent visits.

Prior to the advent of Rural Health Associates, Franklin County Memorial Hospital had no outpatient clinics except one for preschool children and one in family planning. The area's physician-population ratio was nearly 1:2,000. There was one dentist for every 3,675 people. According to RHA's Medical Director, "The large patient population wasn't even getting much crisis care. The care of the others was sometimes uncoordinated and spasmodic, spread among different doctors who might or might not communicate, so the patients could be undertreated or overtreated. And you can't do any preventive medicine when you're bombarded by people who are sick."*

This group practice attempted to develop a model which can be used elsewhere to meet the needs both of patients and of health professionals in rural areas.

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* David Dixon, quoted from Hospital Practice, October, 1973, p. 175.

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To insure that RHA is truly responsive to community needs, its activities were planned with an advisory group which consisted of approximately 25 members, more than 50% of whom were consumers. Many of the consumer members of the advisory group had been picked by the low-income advisory committees of other programs within the county.

Assumptions on which initial telecommunications planning was based included:

- That the basic use for the system would be for patient care.
- That the largest number of consults would be in trauma and accident situations as well as backing up the family nurse associates in medical areas.
- That one use for the telecommunications links would be to reassure the patients that they were indeed being seen by competent and qualified health care providers.

RHA's executive director had been head of the Franklin County Community Action Council and is thoroughly conversant with community needs and citizen demands.

Training

The medexes (ex-military corpsmen), the family nurse associates and the pediatric nurse associates have received considerable training. As indicated above, several of the physicians in the group have taken the opportunity to expand on their areas of special interest so as to be able to make significant contributions to the group practice. However, very little training has been given on the use of television for health care communications purposes. Approximately one hour per person has been devoted to instruction in the use of the equipment.

The switching panel at Farmington is rather complicated, although very simplified instructions are made available as to which buttons should be pushed— and in what sequence— in order to establish communication with either of the two satellite clinics.

Implementation

Although this group has been in existence only since 1971, its staff has grown to more than 60 people, including 6 family physicians, 2 internists, a general surgeon, a pediatrician, 2 dentists, 2 medexes, 3 nurses who are physicians' assistants, seven family health workers, a social worker, a health educator, and other supporting personnel.

Interaction can be facilitated between any two points in the system, but must come through the central switching point at Farmington. The main facility at Farmington includes two studio-type cameras, lights, microphones, and monitors, sufficient to serve a large group of people as when grand rounds, medical conferences, or large teaching sessions are conducted from the Farmington facility.

At each of the Kingfield and Rangeley satellite clinics, there is one large studio-type camera with 10:1 zoom lens, appropriate microphones, 19" television monitor, and lighting equipment. Both satellite clinics are equipped to make X-rays and ECG's. These are readily transmitted via the system. There is one video cassette recorder in the Farmington facility to be used for monitoring or training purposes.

Thermo-electric generators at two mountain-top relay stations (Mt. Blue and Saddleback) provide current for operation of these relays much more economically than would have been the case if power lines had been installed. In the long run, these independent power generators may prove to be more reliable than long power lines which are subject to damage by weather in the region.

Utilization

Although assumptions had been made that most use of the telemedicine system would be for patient care, there had also been an overriding policy: that it was to be used for any kind of communication whatsoever that the users felt important. This "use for everything" policy probably has been responsible for the very wide utilization that is recorded by the principals of this system. Any provider feels justified and secure in asking the opinion or guidance of any colleague on any matter involving patient care. In addition administrative personnel use the system to check on supplies, prescriptions, billings, procedures, etc.

A minor modification which allows the system, when not in use for a visual transaction, to be used in a "voice only" mode running to several points in the Farmington Clinic as well as points at Rangeley and Kingfield can substitute for the long distance telephone. It is estimated that $1,200 to $1,500 per month in telephone tolls can be eliminated by using the audio capability of the system.

Programs in patient health education were not projected at the time the system was planned. Yet two separate series of programs on dietary regimens (salt-free, and diabetic) are being given in three sessions each. The first two sessions of each series are given a week apart. The third session is given a month later, so that patient-participants can have some experience in trying to "live with" the dietary restrictions involved. The third session is open-ended so that it can respond to the experience generated by patients themselves.

Medical meetings and medical grand rounds are held on a regular basis and enable physicians and other professionals not members of the RHA group to participate.

The most striking advantage of the telemedicine system for this group is the way it has brought together physicians and other caring personnel. In the absence of face-to-face contact, the telemedicine system has certified to the members of the group that they do indeed belong to an organization of individuals with whom they are in constant contact.

Considerable future utilizations are planned. Collaboration with the University of Maine Dietary Department will produce further programs for patients on nutrition, weight reduction, and the use of commodity foods. The RHA system hopes to establish links with major medical centers in Portland, Maine and in Boston, so that these rural doctors will be able to obtain consultation from medical center specialists.

Evaluation

In the most general way, this system will try to develop some measure of the cost effectiveness of the telemedicine links. It is seen, however, by the principals of the group that many questions must be taken into account: Were dispositions arrived at more quickly? Was transportation saved for the patient? For the physician? Was the quality of care as good as or better than what the patient would have received had no telemedicine link been available?

13. UNIVERSITY OF NEBRASKA SLOW SCAN RADIOLOGY PROJECT

The Jennie M. Melham Memorial Medical Center in Broken Bow does not have a staff radiologist. Two consulting radiologists in Kearney, Nebraska currently provide service to Broken Bow, by reading X-rays mailed to them daily. Turnaround time is about 4 days.

This slow-scan project is aimed at providing an on-demand assessment of X-rays transmitted from Broken Bow, by a radiologist at the University of Nebraska Medical Center.* If this project is successful, it will indicate a very inexpensive way to provide consultation when requirements are limited to a consideration of the patient's history and examination of static visual information. Roentgenograms, as other "still" pictures, obviously do not have a time/motion component. They can be transmitted in different times, the only requirement being that the amount of information be sufficient.

Technology such as slow-scan video, used here, is important in its own right, but also as an adjunct to other transmission modes, particularly when available bandwidths become crowded. Because standard transmission of video in real-time requires approximately 4.5 MHz of bandwidth, it follows that pictures of comparable quality transmitted on narrower bandwidths require more time for the full picture to be sent. The system used in this project requires approximately 90 seconds to transmit all picture information (525 video scanning lines), but it utilizes ordinary voice-grade telephone wires (Bandwidth: 3 KHz) to do so. Long-distance rates between Omaha and Broken Bow, 250 miles away, are $2.00 for six minutes, enough time to send four pictures, in this case high-quality X-ray films.

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* Normally, UNMC has a radiologist on-site five days a week for sixteen hours a day, and weekends for eight hours a day. A number of staff radiologists are on call for emergencies at all times.

Objectives

The objectives in this project are:

- To evaluate the feasibility and desirability of remote transmission of radiographic images in the daily practice of medicine in urban and rural settings.
- To evaluate the comparative accuracy of radiographic interpretations between family physicians and radiologists utilizing standard film images, as compared to the radiologists' diagnostic evaluation of electronically transmitted images.
- To acquire information concerning system reliability and cost as they relate to health care delivery, particularly in remote and rural settings.

Planning, Training, Implementation

Planning

Since the project is designed to evaluate electronically mediated medical communication of the most complex medical image requiring analysis, the standard radiograph, reference is made in the funding proposal to recommendations of the Nebraska Health Program report, "to establish guidelines for future medical communication needs and to evaluate feasibility, legality and acceptability of these techniques in the practice of medicine." The proposal further states, "An effort will be made to establish the patient cost/benefit ratio and the effect of more rapid diagnosis on patient well-being and total patient in-hospital time."

Much of the planning effort has gone into constructing evaluation methods, which are described below.

Training

The technology requires no more than a few minutes to learn to operate. Furthermore, the user can request, via telephone, a closer view of any point in the picture by referring to a standard grid, similar to that used in road maps, which is located at the edges of the television screen. The receiver reads the coordinates to the distant sender whose monitor is equipped with a similar grid.

Implementation

There is a slow-scan transmitter in the radiology department at Broken Bow (current cost: $2,000-$5,000) and a slow-scan receiver/video disc in the radiology department at UNMC (current cost: $10,000-$12,000). Transmission is by standard telephone lines, using tone-producing and tone-decoding devices attached to ordinary telephone instruments. Costs of this type of technology are expected to be considerably reduced within the next few years.

As soon as an image transmission is completed it can be viewed on a television screen at UNMC's radiology department. Requests for re-transmission or for magnification to 15X of an area can be made immediately, or after viewing a related series.

Pictures of the X-rays are received on a video disc recorder, which will record and retain 5 television images as long as they are wanted. New images can be recorded immediately, erasing the old ones as they are put on the disc. One can "play" the disc as long as one wishes. (A similar but more sophisticated device is used for the "instant replays" in television sports.)

Utilization

Utilization began two weeks prior to this report's deadline. Radiologists at UNMC were, in fact, just becoming familiar with the equipment, when a primary care physician at Broken Bow requested confirmation of gall bladder disease in a male patient. "Case #1 was a 53 year old rancher who presented with painless jaundice. The bilirubin was 4.0 mgs. with a high level of indirect bilirubin indicating obstructive jaundice. The normal bilirubin range is 1.0 mgs. or less. An oral cholecystogram was performed and the physician thought that he had observed filling of the gallbladder and a density in the region of the right upper quadrant was interpreted as being a probable stone in the common duct. The [UNMC] radiologist in consultation noted that the density being observed was indeed the kidney and not the opacified gallbladder and that the radiodensity in the right upper quadrant was some of the contrast material which had not been absorbed from the region of the small bowel. This led to a prompt [less than 25 minutes] diagnosis of carcinoma of the pancreas or carcinoma of the ampulla of vater, and the patient was spared an exploratory laparotomy for removal of a common duct stone." The patient was transferred to a larger hospital in Kearney, Nebraska where the surgeon resected a 5 cm. carcinoma of the head of the pancreas and performed "a cholecystojejunostomy... to provide decompression of the obstructed duct system."* Patient is now receiving chemotherapy on an out-patient basis.

"Case #2 was a patient who fell and sustained an injury to the pelvis. It was difficult to observe a fracture on the original X-ray in the region of the left hip. However, due to the wider density range of the image in the transmitted form, it was apparent to the radiologist at the University of Nebraska Medical Center that there was a fracture of the left hip with maintenance of good anatomic position. In addition there was a fracture of the pubic ramus and ischium which were not visible on the original X-ray until they had been noted on the TV transmitted image."**

"Case 3 was a patient in the early 30's who had been involved in an automobile accident and had sustained severe trauma to the rib cage and a fracture of the left humerus. These fractures were quite obvious to the family physician and the patient was being treated in the hospital for these injuries. Subsequently the patient developed respiratory distress and the X-ray made was interpreted as pleural effusion and/or bleeding into the left hemithorax. The transmitted image was observed and it was easy to determine that there was mediastinal shift toward the left hemithorax indicating that the cause of the opacity in the left chest was not pleural fluid or bleeding into the pleural space, but collapse of the lung due to a mucous plug in the bronchus. The patient was spared an unnecessary thoracentesis (needle tap of the chest) and aspiration of the trachea resulted in clearing of the mucous plug and restoration of the left lung to normal function."

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* William J. Wilson, M.D., Project Director. Personal Communication.

** Ibid.

Radiologists at UNMC have observed that experience tends to increase confidence in the ability to use this medium for diagnosis. Thus far there have been no incidents of transmission failure.

Evaluation

Evaluations are being made on accuracy of diagnosis and quality of the transmitted image. The basic evaluative method is:

- Each film is subjected to four independent readings by the primary care physician, who reads the film at once; a radiologist at UNMC from the slow-scan transmission picture or the same day the film is made; one of the consulting (Kearney) radiologists from the original film, as soon as feasible; and a second radiologist at UNMC at a later date.

- All readers are given history, complaint, etc.

- Randomly mixed with current X-rays are 200 films from sources other than UNMC, Broken Bow, or Kearney, all of which are cases with proven diagnoses. These are given to participants in all four groups at random, directly or via the electronic transmission. The history and complaint are given in the same fashion as for current films. Diagnostic and quality-of-image forms are completed as for current films.

- The total number of observers will be limited to a stable group of twenty.

- The number of films in this evaluation will be approximately 400 per month.

Concurrent with evaluation of radiographs, studies will be made on other types of images: ECG's, printed page information, blood smears, photomicrographs, patient topography features (skin lesions, selected ocular and oral cavity pathology). These latter demonstrations will be educational in nature, non-diagnostic, and designed to test the system for quality of image of other than radiographic data.

14. JACKSONVILLE (FLORIDA) TELEMEDICINE NETWORK

This project began operations in March, 1974. It is administered by the Jacksonville Experimental Health Delivery System, Inc., a non-profit corporation whose principal operating officers are James T. McGibony, M.D., Director, and Edward H. Stansel, Deputy Director.

Jacksonville is an unusual municipality in that it comprises an entire county. Therefore Jacksonville's population of more than a half-million lives in over 800 square miles of territory ranging from urban to rural. Population densities vary considerably. A number of former small towns are included in the present city and intervening areas among them remain undeveloped. Land transportation routes are not only long but circuitous because of the river and estuaries which everywhere compete with dry land.

It is estimated that nearly 24% of Jacksonville's population is medically indigent. Because of the numbers for whom the city must provide care and the dispersal of those numbers throughout an enormous land labyrinth, Jacksonville has elected to explore telemedicine.

Initially, three former public health clinics operating part-time have been converted to full-time community primary care clinics. These three clinics are 8.5, 8.0 and 5.5. miles from University Hospital, Jacksonville, the source of teleconsultation for clinic health professionals. Microwave links, as well as camera, sound, and control equipment have been provided by a grant of $109,268 from the Bureau of Experimental Health Services Delivery Systems (DHEW). An Alcoholic Rehabilitation Center, 4.5 miles from the hospital, has been added to the Network with funding of $30,000 from the State of Florida, Division of Mental Health. Personnel to staff all four locations have been provided by the Consolidated City of Jacksonville.

The Network's basic objective for the three health clinics is to make primary care more accessible to the medically indigent. The objective for the Alcoholic Rehabilitation Center is to provide medical supervision of personnel caring for in-patients.

Services provided, other than primary care and medical supervision are to include: family planning program, expanded pre-natal clinics, expanded stroke prevention and screening program, school health services, mental health education and consultation, urinalyses, sickle-cell anemia testing and immunizations.

The Jacksonville Telemedicine Network became operational March 28, 1974.

15. MIAMI-DADE COUNTY (FLORIDA) CORRECTIONAL INSTITUTIONS TELEMEDICINE PROJECT

This project aims to explore and rigorously evaluate the provision of health services to inmates at the three short-term correctional facilities in Dade County Florida, by the Department of Medicine of Jackson Memorial Hospital, Miami. Two of the principals have staff positions at the hospital and/or teaching responsibilities at the University of Miami School of Medicine. Jay Sanders, M.D., is Chief of Medicine at Jackson Memorial Hospital, C.W. Nordwall is the Director of the Metro Dade County Department of Hospitals and the Executive Director of Jackson Memorial Hospital. Westinghouse Health Systems Division is the program management agent for the University, which is the prime grantee; Westinghouse is also responsible for design, installation and maintenance of the telecommunications system; Louis Sasmor, Ph.D., the third principal, is the onsite Westinghouse Project Manager.

The problems of adequate health care for inmates of detention facilities are compounded by: populations of insufficient size to merit the maintenance of full-time staffs of professionals in many requisite specialties; costs and security risks in the transfer of inmates to hospital facilities; the difficulty of integrating inmate care within a large multisource health care delivery system; variability of care provided by hospital nurses; lack of continuity of care and adequate medical records; and probably, the psychological, social, political influences in the prison environment, on both the inmates and the health care providers.

A well-reasoned approach was proposed by the principals: (1) upgrade the existing system to an improved "baseline" system through nurse practitioner training, introduction of systematic record-keeping and history-taking procedures, and provision of 24-hour emergency telephone consultation; (2) establish telecommunication links; (3) randomly divide patients so half receive care by telemedicine; and (4) evaluate system performance and attitudes as between the baseline and telemedicine cohorts.

The National Science Foundation has granted $906,000 plus cost sharing contributions of $299,000 by the principals to the University and its subcontractors (Dade County and Westinghouse Health Systems) to operate this project for a period of 27 months.*

The upgrading phase began July 1, 1973, the improved baseline system began operations January 1, 1974, and telemedicine operations were to commence July 1, 1974.

The Main Jail, a maximum security facility three blocks from Jackson Memorial Hospital, houses 600 men. It will provide black and white broadband communication via microwave to the hospital by means of a fixed and a mobile camera, as well as electronic stethoscope, ECG telemetry, and facsimile transmission. The Women's Detention Center, one mile from the hospital, houses 125 women. In addition to facilities of the type at the Main Jail, it will provide slow-scan color television pictures via telephone lines. The Stockade, a minimum security facility 12 miles from the hospital, houses up to 650 men. It will provide slow-scan black and white pictures, ECG telemetry, electronic stethoscope, and facsimile transmission via telephone lines.

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* Six months upgrading the existing system to the improved baseline system, six months of operating the baseline system, one year of telemedicine operations, and three months of documentation.

All facilities will provide full audio, and all are equipped with television monitors to view their own outputs. The Main Jail and Women's Detention Center will have television monitors on which the remote consultant can be viewed by those at the penal facilities.

Results of future evaluations of this experiment may be useful for similar short-term detention facilities and some results will be applicable to long-term facilities. Application of results to open populations may be limited, but some analogies may be drawn in the case of rural populations served by a single health system. The development of rigorous, parametric cost benefit analysis is aimed at transferability to a much wider population than prisons.

16. OHIO VALLEY MEDICAL MICROWAVE TELEVISION SYSTEM

This network is a unit organized under the authority of the Ohio Educational Television Network Commission in cooperation with the Ohio Valley Health Services Foundation. Its Project Director is A. Edward Foote. The Chairman of the Ohio ETV Network Commission (and Director of Telecommunications at Ohio State University) is Richard B. Hull. Dave L. Fornshell is Executive Director of the Ohio ETV Network Commission.* Principals' offices are in Columbus, Ohio.

Studies and planning have been underway since 1969 for improvement of health services in the seven southeastern counties which constitute Ohio's Appalachian region. Mental health and retardation and speech pathology were identified as endemic, and there was generally a substandard level of health care. It was decided at an early stage that a microwave telemedicine network would be best utilized in support of the region's isolated and overworked professionals. Consequently, the highest service priority is consultation to be available from specialists in all categories. Next highest priorities are continuing education and in-service training for physicians and nurses, respectively; other allied health professionals will receive educational support; evaluation and therapy in mental health and speech problems will be provided.

A number of tests of various service functions have been conducted since 1969, to determine feasibility and relevance of their content and delivery methods.

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* Reports from 1970 to date make it clear that this project received its impetus and continuing support from Jack E. Farrington, Executive Director of the Ohio Valley Health Services Foundation, in Athens, Ohio, and that William Allen, Jr., an Athens physician, has been another influential guide and supporter.

The consulting tele-center is the Ohio State University College of Medicine in Columbus. Initially, there will be microwave links to O'Bleness Memorial Hospital in Athens, the Athens Mental Health Center, and the Holzer Medical Center in Gallipolis. Additional links to the Nelsonville Children's Center and the Vinton County Satellite Health Center at McArthur are contemplated. This network will utilize full color television.

Support in the amount of $669,000 has been provided by the Appalachian Regional Commission, for the basic network and equipment. This was matched with $135,000 from the Ohio ETV Network Commission. The Ohio Department of Mental Health and Mental Retardation has pledged $107,000 to add the Nelsonville Children's Center to the network. Supplemental funds of $30,471 have been received from the Appalachian Regional Commission.

The Ohio Valley Medical Microwave Television System's date for beginning operations has been pushed back as a result of changes in design (to insure compatibility with the Southeastern Ohio emergency medical service; to improve technical characteristics of the Athens component; to reevaluate control capacity and switching configuration in light of addition of the Nelsonville facility). Delays have resulted from the need to clarify contract language; however, a petition to deny microwave licensing, filed by the American Petroleum Institute with the FCC, has recently been resolved. Finally, construction of two microwave antennas was delayed because the building on which they were to be situated had not been completed. Start of operations at earliest estimate was June 1, 1974.

17. PUERTO RICO TELEMEDICINE PROJECT

Planning for this project was done by the Institute of Social Technology in San Juan, Puerto Rico, as representative of the Department of Health, Commonwealth of Puerto Rico. The principal coordinator is Luis Rivas Calderón, the project's engineer in charge of technical planning and implementation.

The health system in Puerto Rico is based on a regional concept. The island is divided into three health regions, with the San Juan University Hospital receiving research cases from the regional hospitals. The Ponce District Hospital, Regional Hospital for the Southern Health Region, where this project is located, is a 615-bed general hospital, staffed with 73 specialists, 45 of them full-time, and 5 full-time generalists, 11 interns and 31 residents.

Puerto Rico's Southern Health Region serves over 500,000 people. The physician-patient ratio outside the major city of Ponce averages 1/4500, and more than 70% of the region's population receives care through public institutions. During 1972, the patient days in hospital per 1,000 population throughout the region was 550.

The problems of health delivery in rural Puerto Rico are compounded by: the physician and specialist patient ratio; rugged terrain and underdeveloped highways;

a high rate of traffic accidents and other emergencies which strains emergency ward and emergency vehicles capacity.

At an early stage, the planners of this project anticipated a problem which most telemedicine planners, often to their later dismay, have either ignored or avoided—the acceptance of the telemedicine concept by the professionals for whose use it is intended. A survey of prospective users of the Puerto Rico Telemedicine Project showed that those who were most involved in planning are most likely to use telemedicine, those least involved tend to lose interest in it; specialists are least likely users unless, one assumes, they are involved in planning; and those who are to be served are more likely to use the telemedicine facility than those who provide service.* System design has been oriented toward the use of the system by the medical staff, as an integral part of their functions.

The anticipated main uses for telemedicine in the Southern Health Region of Puerto Rico include: consultation for emergency services and primary health care delivery; inter-staff consultation; education and in-service training of physicians and paramedical personnel at participating institutions; interhospital conferences; analyses of X-rays, ECG's and other tests; patient education and other communication system uses on a time-available basis.

Objectives and goals further include: diminishing the number of incorrect referrals from other hospitals in the region to the Ponce District Hospital; decreasing time in which medical services are delivered to rural areas; increasing use of paramedical resources, especially when physicians are unavailable; increasing the number of medical services available outside Ponce; and decreasing the sense of isolation of physicians working in small towns and/or in sub-regional facilities.

The first major phase of the project will connect Ponce's Regional Hospital with Guayama's Area Hospital, a 62-bed municipal hospital with a staff of 13 full-time physicians, including 8 specialists. The Guayama area Hospital, located in a city of 37,000 habitants, serves a population of about 90,000 people, including three smaller towns, whose Health Centers refer cases to Guayama. During 1972, the Guayama Hospital registered 52,000 outpatient visits and admitted approximately 2,900 inpatients with an average stay of 7 days per patient.

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* This question was put to prospective users several times at varying intervals during the planning phase: "When the telemedicine project has been initiated, do you think you will use the system?" (choose one): everyday (5 points); frequently (4); from time to time (3); hardly ever (2); never (1).

Preliminary survey results indicated:

1) People who have the opportunity to participate in all planning decisions tend to rate themselves as high frequency users (3-5). The rate of anticipated use increases proportionately with the amount of involvement of the participant in planning.

The interconnection is to be via microwave. Guayama is 35 air miles from Ponce, approximately 70 minutes by road during normal conditions. Microwave relay between the towns is located at Salinas Hospital in the Guayama service area but located midway between Ponce and Guayama.

One video channel from Guayama to Ponce is a 10 MHz bandwidth, which will permit video of superior resolution (around 750 horizontal lines). Another video channel from Guayama to Ponce is a standard broadcast channel. Thirteen additional channels will provide for voice transmission, stethoscopy, EEG's, ECG's,vital signs, telewriter, camera remote controls, hospital switchboard interconnection, fault alarm, and system testing.

From Ponce to Guayama there will be one standard resolution video channel, and seven channels for voice, remote controls, telewriter, hospital switchboard interconnection, fault alarm, and system testing.

Equipment will include black and white video (with provisions for color video expansion), sound, the facilities implicit in the transmission capabilities listed, a video pointer at Ponce, a special effects generator to provide split screen transmission of two camera images simultaneously at Guayama, and close-up adapters for the zoom lenses. Camera-monitor carts will provide transmission capability from other locations in addition to the tele-centers at each hospital.

Funds of approximately $550,000 have been provided by the government of the Commonwealth of Puerto Rico for equipment and additional personnel.

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2) The anticipated use rate is inversely proportional to training and experience of the participant; for example, physicians who are specialists and have practiced their specialties for more than five years tend to anticipate their use as low (1-2).

3) Participants in Guayama tend to anticipate a higher frequency of use than those in Ponce.

4) The anticipated use rate declines over time for those who are not at all involved in planning.

Source: "Criteria for an Experiment in Health Services Telecommunications in Puerto Rico," prepared by Janet Weiss Eckerling, Senior Research Associate, The Institute of Social Technology, published by the Institute, San Juan, December 31, 1973.

(This author's observation of prospective participants in Ponce, in January, 1974, though limited to a small sample of specialists, was one of enthusiastic anticipation of upcoming operation. Questioning on the site indicated that many participants were now involved in planning uses for telemedicine).

Plans for the Puerto Rico Telemedicine Project anticipate extension to facilities at Yauco, Coamo, Adjuntas, and Jayuya the principal rural and area hospital zones of the region, when and if experience with the Guayama-Ponce link has established the value of the concept.

18. SATELLITE EXPERIMENTS (ATS-6 Satellite Advanced Health Care and Education Experiments)*

"The satellite will be in operational orbit over 94° west longitude. This satellite is sufficiently powerful to provide quality television with simple, relatively inexpensive ground terminals. The Lister Hill National Center for Biomedical Communications has been designated as the DHEW focal point for coordinating health experiments over this satellite. The Center is involved in the following experiments:

"Alaska Health Experiment: This experiment will implement a coordinated telemedicine and health information system at four health facilities in Alaska. Audio/data/video communication links will be provided between primary health care providers (community health aide and nurse) with physicians at a Service Unit Hospital and medical specialists at the medical center in Anchorage. Television equipment and biomedical telemetry instruments will permit medical diagnosis and consult, and the capability of general practice physicians at a Service Unit Hospital will be augmented by consultation with specialists at the Anchorage Native Medical Center. Video will be provided for continuing education of isolated health professionals as well as direct health education for the Native population.

"It is expected that the use of these communication technologies will eliminate unnecessary patient transfer from the village while increasing more appropriate referrals to medical specialists; provide an increased level of preventive health maintenance procedures; facilitate earlier disease detection and medical intervention; provide improved continuity of care through improved follow-up procedures; provide the Native population with improved understanding of health and the health care system; increase availability and use of medical specialists at the village level; reduce travel by medical specialists to remote villages; and assure provider compliance with disease-specific standards of health care."

"The ATS-F satellite [ATS-6 after launch] will be used for the video links, while audio and data links will be via the ATS-1 spacecraft."

"Regional Medical School (WAMI): The experiment will apply interactive audio, data and television to the solution of problems encountered in providing basic science education to students remotely located from a major medical school. Most course material will originate at the University of Washington in Seattle and flow to students at Fairbanks in Alaska."

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* All material in this subsection is quoted from a summary of activities dated March 15, 1974, by Harold Wooster of the Lister Hill National Center for Biomedical Communications, National Library of Medicine, Bethesda, Maryland.

"However, some programs will originate at the outlying sites and be evaluated by the staff at the University. Video and audio will also be used to provide administrative conferencing between officials at all locations, for counseling students, for interaction between students to relieve the feelings of receiving an inferior education off-campus, and for computer evaluation of students' progress in specified areas."

"Undergraduate clinical and continuing education will be carried out between the University of Washington faculty and third and fourth year medical students in clerkship under practicing physicians in Omak, Washington. Both local faculty at the University and peripheral faculty at Omak will review and critique the students' patient presentations. The physicians at Omak will on occasion present patients to specialists at Seattle for consultation, thus enhancing their ability to handle cases locally."

"Satellite communications has great potential impact on the problems of maldistribution of health manpower. The location physicians choose to practice medicine shows a high degree of correlation with the location of their final graduate training. Telecommunication linkages between major medical centers and training centers in shortage areas may obviate the obstacles to establishing residency training centers in areas of physician shortages. The improved communications can also provide the necessary continuing education for physicians and other health professionals in remote areas in order to improve the quality of care and can provide an incentive to individuals to practice in such areas. A satellite could also provide the necessary linkage between established medical schools with existing universities in states having no medical schools. These universities can then develop the equivalency of two-year basic science medical schools in such states. The necessary linkages between established academic medical centers in other states with newly developed clinical programs can also be accomplished via satellite. This can provide the clinical training for a major part of the medical school."

19. STARPAHC

The acronym derives from Space Technology Applied to Rural Papago Advanced Health Care.

This project is being formed by the Papago Tribe, the HEW Health Services Administration, the Indian Health Service Center for Research and Development, the Lockheed Missiles and Space Company, and the National Aeronautics and Space Administration (NASA) Life Sciences Directorate of the Lyndon B. Johnson Space Center in Houston. Principal planners have been Norman Belasco and Sam Lee Pool, M.D., of NASA, J.H.U. Brown, Ph.D., E.S. Rabeau, M.D., and J.W. Justice, M.D. of HEW.

8,000 to 10,000 Papagos are permanent residents of 75 villages on the 4,462 square mile Papago Reservation in the desert along Arizona's southern border and the surrounding area. The Indian Health Service provides comprehensive health care delivery for the Papago Reservation, based on a well-equipped community hospital at Sells, Arizona, a health center at Santa Rosa, the Tucson Computer Center (which maintains records on all Papagos with whom IHS has made contact) and the IHS Hospital in Phoenix (a tertiary center with staff specialists). IHS nurses and community health workers are in the field as well as at the various facilities. Physicians are in attendance or make regular visits at the facilities. The up-to-date computer records are accessible by allied health personnel and physicians functioning as stationary and mobile facilities. The IHS maintains ambulances and other vehicles for transportation among its various installations.

The STARPAHC system is designed to upgrade the existing system through instantaneous microwave communications among all facilities, ambulances and field personnel and by using allied health personnel under direct supervision of physicians via TV and audio networks. In addition a mobile health unit which is essentially a field hospital with pharmacy, X-ray, laboratory and emergency room facilities, will be put into service. Sells Hospital will be the control point for the system providing the capability of direct physician supervision of the care being delivered from remote fixed and mobile operations. It will have two-way broadband (full TV) and voice and data communication with the Santa Rosa Health Center and the mobile health unit, slow-scan TV and voice and data communication with the Phoenix Referral Center, and digital data communication with the Tucson computer center. Allied health personnel at remote fixed and mobile clinics will have digital data communication with Sells and through Sells to Tucson when so directed by a physician. All digital field units will be capable of making inputs to the Tucson computer as well as getting data from it. A suitcase-size emergency module will enable field personnel to provide on-the-spot emergency services, transmit telemetered information, and be in voice contact with other units.

The projected level of health care envisioned in this highly sophisticated system demonstration far exceeds that available to most remote rural areas and many inner cities.

One of the objectives of STARPAHC is to gain experience in the development of a medical services system for long duration space missions on the assumption that, from a systems point of view the communications, data management, and equipment requirements could be very similar to those required for a future manned spacecraft (remote area) health services system. Another is to utilize space technology to improve delivery of health care on earth.

STARPAHC will be operational for two years (1975 and 1976), following completion of its design and assembly phases. The project, overall, will have had a four year duration. Contract funds of $3,352,000 have been made available through NASA. In addition the project utilizes contributions by the Department of HEW of facilities, personnel, and supplies.

20. VETERANS ADMINISTRATION, NEW TELEMEDICINE PROJECTS

In addition to currently operational projects supported by the Veterans Administration (See Massachusetts General Hospital-Bedford, Mass. Veterans Administration Hospital, and Nebraska Veterans Administration Hospital Network), the V.A. launched three additional projects, all of which were to be in some degree of operation in fiscal 1974.

Responsibility for initiation of new health services support via interactive television resides in the Learning Resources Service* of the V.A.'s Dept. of Medicine and Surgery.

Applications Technology Satellite-F (ATS-F)**

"With the Veterans Administration, which is the largest health delivery system in the western democracies, communications are inevitably complex and enigmatic. The remote and frequently isolated locations of a large number of the V.A. hospitals preclude any regular, wide-spread use of ground based video or telemetry interconnection due to the prohibitive cost of such links; yet the need for interactive consultation and educational hookups among remote hospitals and metropolitan medical centers is made greater by the same factors of distance and isolation that create the high costs. The communications satellite has a unique capability for meeting these logistical problems. The opportunity to conduct limited experiments with satellite communications appears to be especially advantageous for the V.A. system."***

Based on the above rationale, the V.A. decided in June 1973 to participate in ATS-F experiments and to coordinate design and purchase of compatible equipment in coordination with the other members of the consortium of ATS-F experiments. Ten V.A. hospitals in the Appalachian region were selected as the participants: Altoona, Pa., Beckley, West Va., Clarksburg, West Va., Dublin, Ga., Fayetteville, N.C., Mountain Home (Johnson City, Tenn.), Oteen, N.C., Salem, Va., Salisbury, N.C., Wilkes-Barre, Pa.

Probable V.A. experiments during the eleven month orbital period of the satellite were outlined by the close of fiscal 1973 to include teleconsultation, video seminars, grand rounds, workshop discussions, outpatient clinic activities and computer-assisted instruction.

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* Specifically, the Office of the Chief, Systems and Technology Division, Learning Resources Division, Department of Medicine and Surgery, Veterans Administration.

** Note other ATS-F (ATS-6 after launch) applications at "Satellite Experiments" above.

*** Annual Report, EMI program, FY 1973, V.A. Dept. of Medicine and Surgery, Education Service, p. 21

Experiments will be conducted on Wednesday afternoons. Live television demonstrations in color or black and white will be beamed via ATS-6 to Appalachia from Denver. Teleconsultations and selected other sessions will send return video from Appalachia via land-line slow scan. All seminars, grand rounds, teleconsultations and out-patient clinics include switched audio carried on ATS-3, a previously launched satellite. Appalachian locations will see not only the live transmissions from Denver, but also the static pictures from other Appalachian locations and will be able to hear and interact in the audio mode.

Interactive Closed Circuit Television System: Temple, Texas V.A.H.; Marlin, Texas V.A.H.; Waco, Texas V.A.H.

The closed circuit microwave system serving the above V.A. hospitals, "will become the core system in central Texas, with eventual possible linkage of several non-V.A. organizations for the mutual benefit of both the public and private sectors. The Scott and White clinic located in Temple presently has closed circuit linkage with V.A. Hospital Temple and will, therefore, be a part of the network."*

The linking of V.A. and non-V.A. hospitals so as to facilitate rapid exchange of medical information is in keeping with the intent of the V.A. Exchange of Medical Information program and the V.A.'s policy of regionalization.

In fiscal year 1973, purchase of equipment for this system was initiated.

Veterans Educational Training Extramural Regional Audiovisual Network (VETERAN).

This system will interconnect three V.A. Hospitals: Marion, Ill.; Poplar Bluff, Mo.; John Cochran Division and Jefferson Baracks Division of the V.A. Hospital, St. Louis, Mo. Like the system linking three Texas Veterans Hospitals, this system not only provides exchange of medical information among V.A. institutions in a region** but also contemplates access to the resources of medical schools and other major health care delivery facilities in the St. Louis area, thus linking public and private health care delivery institutions.

Design of the closed circuit system and purchase of equipment for the four V.A. Hospitals in Missouri and Illinois were undertaken in fiscal 1973.

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* Annual Report, op. cit., pp. 45-46.

** Note that here, as in other V.A. situations, remote institutions are linked with institutions in metropolitan centers with medical teaching facilities, thus regionalizing the exchange of medical information.

CHAPTER V

STUDIES OF ASSESSMENT CAPABILITY AND ACCEPTANCE OF TELEMEDICINE

(Diagnosis, general ... Cardiac auscultation ... Dermatology ... Radiology ... Psychiatry ... Mental Retardation ... Speech Therapy ... Patient and Professional Acceptance ... Other Studies.)

By January, 1974, telemedicine had not generated a large number of specific studies of assessment capability or acceptance of the medium by patients or professionals. The studies reported in this section represent what the author found had been done to date.

Some study results omitted in this section are reported in Chapter IV,"Current Projects in Brief," or in Chapter II, "History" because they seemed relevant to their particular projects and had not been extrapolated to telemedicine generally. Such project-specific studies are noted in this section when their subjects are related to the matters covered here.

Diagnosis, general

In 1969, a study was made of the first 1,000 patient transactions on the Logan-Massachusetts General tele-diagnosis system.[1] "Feasibility of tele-diagnosis in this study was assessed by obtaining the opinion of the responsible physicians and nurses and that of an independent medical observer as well as by analysis of the components of medical diagnosis. ... To assure their safety, patients seen by television were also examined in person by a physician at the medical station. This provided the opportunity for both the tele-diagnosis physician and the direct observer to evaluate independently whether a reasonable disposition of the patient had been made.* The tele-diagnosis physician tended to be a harsher judge of the feasibility of the television transactions ... than did the physician who directly saw the patient. In our opinion this is explained in the following way. The tele-diagnosis physician since he was working with a new system felt a certain uneasiness. Despite this, he was able to evaluate the patient and arrive at a reasonable disposition. This was true in 96% of the cases as judged by the direct observer who after examining the patient concluded that his own disposition would not be significantly different." "When present with the patient the physician uses medical history, physical examination, laboratory, and roentgenological studies to arrive at his diagnosis. It is obvious that much of this can be done at a distance. History taking, even with regard to personal information contained in psychiatric interviews** is readily done by the remote physician. Face-to-face confrontation provides mutual visualization of even the subtleties of facial expression and posture, allowing the medical interview to proceed in a manner quite familiar to both the patient and the physician."

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* This evaluation was made on the first 200 patient transactions, as noted in the report on MGH in Chapter IV.

** See Psychiatry, below.

"Many aspects of the physical examination, particularly those which depend on inspection are easily and accurately performed. The complete range of motion of any part of the body, the body habitus, the presence of swelling, etc. are determined with little difficulty. Fine details of surface anatomy can be clearly visualized."

"The current system is in black and white. The addition of color television would permit certain diagnoses to be made more readily but the exact role of color perception in medical evaluation has never been defined. Dermatologic diagnosis,* which would seem to be highly dependent on recognition of color can be made in most cases in black and white. In a pilot series of 56 patients with previously identified skin problems, the consulting dermatologist was able to reach the correct diagnosis via this interactive telemedicine system as on direct visualization in all but three cases. He was unable to diagnose one case on direct examination. The cause for incorrect diagnosis in the other two is not known but may be related to lack of color perception."

"Auscultation is readily carried out."**

"Percussion and palpation are not yet easily performed at a distance. Currently reliance on allied health service personnel is necessary to make observations which depend on these diagnostic methods. In a tele-diagnosis system, the physician retains the ability to supervise the performance of this kind of task. He can observe the exact location of the abdominal tenderness as well as simultaneously evaluate the manner in which any diagnostic maneuver is performed. (e.g. Psoas sign was elicited, the McMurray test performed, etc.)"

"A relatively complete neurologic examination can be performed quickly once the tele-diagnosis team has become familiar with the operation of the system."

At the time of this study, the then current capability of instrumentation with respect to a complete physical examination was summarized on a chart which has been adapted from the standard physical examination sheet (form 10004) in use at Massachusetts General Hospital. *** The authors go on to say that "it is important to emphasize that a number of the items not checked can be reasonably assessed depending on the training of the nurse or other allied health service person at the remote site."

"Most laboratory studies can be performed in a peripheral station if facilities are available ... in situations where first-hand information is desirable, the telemicroscope can be employed. The peripheral blood smear and the urine sediment can be clearly visualized by this instrument. The lack of color perception with the current system can be offset by proper communication between the remote examiner and the nurse."

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* See Dermatology, below.

** See Cardiac Auscultation, below.

*** See Table I.

MASSACHUSETTS GENERAL HOSPITAL
PHYSICAL EXAMINATION SHEET

✓ = Current Capability of Tele-diagnosis

HABITUS	☑ w. d. and n.	☐ Color	☐	☐	☐
SKIN	☐ Warm	☑ Moist	☐ Pigmentation	☑ Lesions	☑ Hair
HEAD	☑ Size	☑ Shape	☐	☑ Face	☐
Eyes	☑ Vision	☑ Prominence	☑ Conjunctivae	☐ Scleras	☑ Fields
Pupils	☑ Equal	☑ Round	☑ React. light & distance	☑ Extra Ocular Muscles	☐ Fundi
Ears	☑ Hearing	☑ Discharge	☐ Drums	☑ Mastoids	☐
Nose	☐ Obstruction	☑ Discharge	☐	☐ Smell	☐
Mouth	☐ Mucosa	☑ Lips	☑ Angles	☐	☑ Metal line
Tongue	☑ Surface	☑ Midline	☑ Tremor	☐	☑ Speech
Teeth	☑ Functionally Adequate	☑ Denture Upper	☑ Denture Lower	☐ Tooth Pathology	☐ Pyorrhea
Throat	☐ Color	☑ Exudate	☑ Pharynx	☐ Palate	☑ Voice
Tonsils	☑ Present	☑ Size	☑ Surface	☐ Crypts	☑ Exudate
Neck	☑ Inspection	☑ Motion	☐ Palpation	☐ Thyroid	☐ Trachea
Lymph Nodes	☐ Cervical	☐ Axillary	☐ Inguinal	☐ Epitrochlear	☐ Supraclavicular
CHEST	☑ Shape	☑ Symmetry	☑ Expansion	☐	Cardiac Measurements
Breasts	☑ Development	☐ Glandular consistency	☐ Masses	☑ Nipples	R L
					1
Heart	☑ Apex seen	☐ Felt	☐ Thrills	A_2 P_2	2
Sounds	☑ Regular	☑ Quality	☑ Murmurs	B. P. ✓ /	3
Pulses	☐ Equal	☐ Synchronous	☐		4
Lungs	☐ Resonant	☑ Breath sounds	☑ Rales		5
	☐ Diaphragm Position	☐ Diaphragm Excursion	☐ Tactile Fremitus	☐ Vocal Fremitus	6
ABDOMEN	☑ Contour	☑ Scars	☐ Soft	☐ Tympanitic	☐ Peristalsis
	☐ Tender	☐ Spasm	☐ Masses	☐ Liver dullness	☐ Edge not felt
	☐ Spleen not felt	☐ Kidney right felt	☐ Kidney left not felt	☐ Costo-vertebral tenderness	☐ Hernia
Vagina	☑ Labia	☑ Clitoris	☐ Mucosa	☐	☐
	☐ Anterior Wall	☐ Posterior Wall	☑ Perineum	☑ Discharge	
Uterus	☐ Cervix	☐ Fundus	☐ Anterior Position	☐ Posterior Position	☐ Mobility
Vaults	☐ Ovaries	☐ Masses	☐ Tenderness	☐	☐
Rectum	☑ Hemorrhoids	☐ Sphincter tone	☐ Tenderness	☐ Masses	☐ Prostate
Male Gen.	☑ Penis	☑ Scrotum	☐ Testicles	☐ Epididymes	☐ Cords
EXTREMITIES, Upper	☑ Strong	☑ Coordinate	☑ Tremor	☑ Bones	☑ Joints
Circulation	☐ Color	☐ Brachials	☐ Radials	☑ Sweating	☑ Clubbing
EXTREMITIES, Lower	☑ Strong	☑ Coordinate	☑ Tremor	☑ Bones	☑ Joints
Circulation	☐ Color	☑ Veins	☑ Edema	☐	☐
	☐ Femoral	☐ Popliteal	☐ Dorsalis Pedis	☐ Posterior Tibial	☐
REFLEXES	☑ Triceps	☑ Knee Jerks	☑ Achilles	☑ Plantar	☑ Ankle Clonus
	☑ Kernig	☑ Romberg	☐	☐	☐
MENTAL—EMOTIONAL	☑ Intelligent	☑ Co-operative	☑ Oriented	☑ Emotionally Stable	☐

TABLE I

Adapted from M.G.H. form # 10004

"When necessary, electrocardiograms can be transmitted by microwave with less than 2% variation in the magnitude of the recorded wave form. In most clinical situations, however, visualization of the electrocardiogram taken at the remote site is more practical."

"Roentgenograms can be accurately interpreted. Differences in classification of 100 chest radiographs viewed direct and by this telediagnosis system could be accounted for by observer variability."*

"Thus the major limitations to telemedicine are in the realm of physical diagnosis. This of course, means that it is not feasible to practice certain forms of medicine at a distance. Gynecologic palpation is not currently possible."

The authors conclude: "Tele-diagnosis is feasible. The combination of a health telecommunications system with task allocation to allied health services personnel in participation with the professional nurse serving as a clinician can with current technology be used to increase availability of medical care. It can help bring the special knowledge and skills of the teaching hospital and medical center to remote as well as less remote medically disadvantaged areas. The challenge to those interested in patient care is to find ways to translate the feasible into the real. This study ... suggests that a telecommunications system, in conjunction with a skilled professional nurse clinician or practitioner, can be used to manage successfully over 90% of the general medical problems seen at a primary care ambulatory medical facility."

Cardiac auscultation

Fifty persons, twenty-seven of them patients whose diagnoses had been established by thorough evaluation and twenty-three of them volunteers from a Normative Aging Study were examined by a single observer in person and via the Massachusetts General Hospital - Logan Airport telemedicine system.[2] The examiner completed standardized examinations (one at the apex and one at the left sternal border, 4th intercostal space) on each subject directly and via telediagnosis, within several days of each other; telediagnosis preceded direct auscultation in about 25% of cases. During the telediagnosis examination the video link was turned off, so there was no chance the physician could recognize a subject. The examiner heard only heart sounds and murmurs before making his decision as to their characteristics. No clues as to medical history or physical findings were provided during the tele-auscultations. Positioning of the telestethoscope was done by a physician at the distal site.

"Each systolic murmur heard at the apex by direct auscultation was also heard via the telediagnosis system. In 26 cases, no systolic murmur was heard at the apex during either the telediagnosis or the direct auscultation. Despite the absence of false positives and false negatives, there were slight differences in grading. Nineteen of the 24 murmurs heard by direct auscultation were graded identically by tele-auscultation. There was a difference of one grade in five cases; three of these were considered louder by direct auscultation. Similar results with regard to systolic murmurs were obtained at the left sternal border."

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* See Radiology, below.

"The results with respect to diastolic murmurs are more difficult to interpret. At the left sternal border all murmurs heard on direct auscultation were also heard by telediagnosis. Differences in one grade were present in two cases and two grades in one case. However, two of the eight diastolic murmurs heard at the apex on direct auscultation were not heard by the telediagnosis physician. Both were faint (GR 1/6), rumbling murmurs. These were the only two of the 32 grade 1/6 murmurs in this study missed by teleauscultation."

"The classification of murmurs with respect to quality presented no significant problems. The findings at other sites of auscultation did not significantly differ from observations at the apex and left sternal border. Review of hospital charts on the patients in this study demonstrated that variations in classification of murmurs of one grade were not uncommon on direct auscultation by different observers and even the same observer on different days."

In discussing results of the study the authors state:

"The accurate interpretation of all but the faintest heart murmurs transmitted by microwave offers evidence for the feasibility of providing cardiac consultation at a distance. The causes for the minor discrepancies noted in this study are not apparent at this time. The two diastolic rumbling murmurs missed were both missed in the early phases of this study when the medical station was located adjacent to an airport runway and ambient noise was high. After the site was moved to a less noisy area and acoustical drapes were installed in the examining room no faint murmurs were missed. Errors of grading became as frequent in the one grade higher category as in the one grade lower. Future systems should be designed to indicate when the sound intensity of the output of the telestethoscope is equivalent in intensity to the input at the stethoscope microphone."

Dermatology

Summarizing another study which utilized the Massachusetts General - Logan Airport link to assess the capacity of television to transmit pictures of dermatologic lesions,[3] Murphy, Fitzpatrick et al state:

"Comparisons of diagnosis made by black and white television viewing of slides of dermatologic lesions to those made by direct viewing of the same color slides reveal that in 85% to 89% of the cases the dermatologists were as accurate by television as on direct examination. Color television improved accuracy only slightly, but was more acceptable to the dermatologists as less time was required to reach a diagnosis. Considerable work must be done to improve facility of dermatologic inspection by television. Focusing, zoom control, camera positioning, and lighting require particular attention. This study demonstrated that dermatologists can diagnose color slides by black and white television more accurately than nondermatologists viewing direct projections of the same color slides."

The study was conducted in four phases:

Phase I: Black and white television versus direct viewing of color slides

A dermatologist otherwise not involved in the study selected 75 color transparencies from the more than 10,000 slides filed by the Dermatology Service of the Massachusetts General Hospital and Harvard Medical School. His sole criterion for selection was that, in his opinion, a slide was sufficiently representative of a particular disease to make diagnosis possible by viewing the slide. Two dermatologists (#1, a hospital staff member; #2, a professor of dermatology) viewed the slides independently. Each dermatologist first viewed a slide on a 17-inch black and white television monitor, and recorded his diagnosis. He was allowed to ask questions about the color of the lesion— as he would in a similar actual situation— but was not provided with any other clinical information. Next, he viewed the slide directly projected in color (2.5 x 3 feet image) and again recorded his diagnosis.

Observer #1 interpreted 85.3% of the slides as correctly by black and white television as on direct viewing of the color slides. Observer #2's comparable figure was 89.3%. Television diagnosis was less accurate than direct viewing in five cases for Observer #1 and in one case for Observer #2. A surprising finding was that each observer was more accurate by television than by direct viewing in two cases.*

Phase 2: Color television versus black and white television

Forty-five slides were selected in the same manner as for Phase 1. Observer #1, alone, made diagnoses as accurate by black and white as by color television in 93% of cases. When this observer subsequently viewed an additional 45 slides in the Phase 1 mode (black and white TV versus direct projection) his comparative accuracy was now 93%, also.

Phase 3: Dermatologists using black and white television compared to other physicians viewing color slides directly

Two internists viewed the same 75 slides used in Phase 1. Here, the study was to determine comparative diagnostic accuracy. Dermatologist Observer #1 had achieved 87% diagnostic accuracy and Dermatologist Observer #2 64% diagnostic accuracy in viewing the slides on black and white television. The two internists, viewing slides directly in color achieved diagnostic accuracies of 33% and 31%, respectively.

The authors state, "The greater than twofold increase in diagnostic accuracy obtained by the dermatologists compared to the internists under these conditions indicates that actual consultative situations via television would be likely to be helpful."

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* Diagnostic accuracy, agreement with the diagnoses made by the dermatologists who had actually seen the patients and taken the photographs, was 85% for Observer #1 on direct viewing of slides and 87% on black and white television viewing; Diagnostic accuracy for Observer #2 was 68% and 64%.

Phase 4: Additional patient experiments

Eight patients with a total of 12 skin lesions were examined independently by a dermatologist using black and white television and by a clinic physician who viewed them directly. The diagnoses were equivalent in ten lesions. Lighting amd camera problems prohibited accurate diagnosis in the remaining two cases. The experiment was terminated because it was realized that adjustments were needed in order to improve the cumbersome technical system.

Several observations were made as a result of this study:

- Although there was little difference in accuracy, color television was more acceptable to the dermatologists than was black and white. Diagnoses took less time with color TV (average 2.0 minutes) than with black and white TV (average 4.5 minutes).
- Absence of color on the black and white monitor tended to accentuate certain parts of a lesion which were not so prominent on the color slide. *
- Use of color photos denied observers the opportunity to cross-light lesions, as they can with "live" patients, to accentuate third-dimensional aspects of lesions.
- With use of a camera in a fixed position, it was difficult, using zoom lenses, to view the whole body and then zoom in on a small area while keeping the image in focus. Camera position, lighting, and lens capacity all required considerable adjustment which made the dermatologist's tasks clumsy to perform.
- Because physicians using black and white television had to ask the distant observer about colors of all or parts of lesions, some predictable difficulties arose. In one case, pityriasis rosea looked merely pink rather than brownish-pink to the observer. Therefore, the diagnosing physician was misled. In general, however, report of color by the person seeing it directly proved to produce few such problems.
- Accuracy of diagnosis of the slides was artificially low, due to the focus of the experiment on diagnosis done solely by visualization. Medical histories were not available, nor was it possible to assess hardness of the lesion. In a real situation, the patient's history would be available, and induration could be evaluated with close cooperation from the professional attending the patient.

Results of an experiment in dermatologic consultation via color television by the New Hampshire/Vermont "Interact" system, in 1973, are reported in the section on that system in Chapter IV.

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* [Author's note: The plumbicon cameras in use "read" tones in the red end of the spectrum as slightly darker than true gray-scale value, and tones in the blue end of the scale as slightly lighter.]

Radiology

The standard X-ray is the most complex two-dimensional medical image requiring analysis. Therefore, accuracy of detail in X-rays is a good test of telemedicine's transmission and reception capabilities. Investigators utilizing the facilities of Massachusetts General Hospital's telemedicine system have prepared four reports (4), (5), (6), (7) dealing with X-ray images transmitted and received via television.

The first of the Massachusetts General X-ray papers, "Microwave Transmission of Chest Roentgenograms" (4) reported: "Comparisons were made of the interpretations of roentgenograms viewed directly and after transmission by microwave. Observed differences could be accounted for by intra-and inter-observer variability. It was concluded that microwave transmission of chest roentgenograms is feasible with currently available techniques. This and other currently available techniques can be applied to the care of persons in remote and medically disadvantaged urban areas."

This study was based on 100 posteroanterior and lateral roentgenograms ... "selected from the files of a hospital specializing in the care of patients with tuberculosis. The official interpretation by the hospital radiologist ... was obtained from the hospital records. Three physicians with particular interest in chest diseases ... viewed these roentgenograms via the Telediagnosis system."

"The films were placed on a standard view box at the Logan Airport Medical Station. The observers were located 2.7 miles away in the emergency ward of the Massachusetts General Hospital. They directed the remotely controlled camera by a directional switch and adjusted the zoom lens and focus control by push buttons to obtain panoramic and detailed views of each radiographic view."

"The observers were not given clinical information about the patients at the time of this interpretation, but they knew that a large percentage had tuberculosis. The previous radiographic interpretation was not known. The panelists were asked to describe roentgenograms with regard to the presence and extent of abnormalities consistent with tuberculosis according to standard criteria. For the sake of simplicity they assumed that all shadows that could be considered consistent with pulmonary tuberculosis be classified as such. ..."

"All three panelists reached agreement on classification in 92 cases, but were unable to agree in 8. In cases of disagreement, the interpretation of two of the three panelists was regarded as the panel interpretation. These were compared with those of the hospital radiologist obtained from the chart. ... There was no disagreement between the classification made in 77% of the cases. The major difference was a tendency to classify disease one category greater in severity than was recorded on the hospital chart. Twelve cases of moderately advanced disease were called far advanced, and three cases of minimal disease were classified as moderately advanced. This tendency to 'over-read' the roentgenograms by television was greater than the 'under-reading.' Minimal tuberculosis was called normal in one case and moderately advanced disease was called minimal in four cases."

The hospital radiologist re-read the same 100 films six months later by television. "There was no disagreement between his direct interpretation and those he made by television in 90% of the cases. Minimal disease was not overlooked. The principal difference in interpretation was in minor variations between minimal and moderately advanced or moderately advanced and far advanced. To measure his intra-observer variation on direct viewing, these direct interpretations were compared with [his own previous interpretations] ... Overall agreement was 89%, and minimal disease was not overlooked. Minimal differences in categorization of roentgenograms were again seen."

"Observer variability was the principal difficulty encountered in this study ... The significant observer variability noted can mask variation due to the telediagnosis system. Review of individual errors, however, suggests that if this did occur it was small."

In the second radiologic study at Massachusetts General [5] an attempt was made to determine whether X-rays transmitted via television could be recorded on video tape for later review by a remote radiologist. The authors state, "The extent to which medical diagnosis depends on the use of radiology, and the volume of roentgenographic data generated, imply the danger of a serious shortage of radiologists. The problem will be aggravated by expected trends in health care delivery which will shift the preparation of more X-rays to extra-hospital facilities. The use of two-way television communication may offer a potential means for increasing the productivity of available radiologists by allowing them to view X-rays remotely. Straightforward assessment of the image quality is difficult, because the requirements in terms of physically measureable parameters are not known; the only criterion is that accurate roentgenological interpretation can be achieved on television visualization of the X-ray ... The image quality obtained on playback of a video tape recording has been compared to the quality of the live picture, using a specially prepared resolution chart in a configuration which permitted variation of the scene contrast. The recorded image hardly differs from the live image in resolution as a function of contrast. Since live television presents an adequate picture of X-ray interpretation, video tape recording appears promising in roentgenological applications."

In the third Massachusetts General paper on the subject of teleradiology[6] in answer to what the authors noted as a universal response —. "instant criticism, particularly by the specialist" — Andrus and Bird examined two major objections to teleradiology: 1) That standard television resolution is immutably limited both horizontally and vertically, and 2) that the corrective for the limited resolution must be some systematic pattern of scanning of an X-ray film. Addressing point one, they noted, "It is not possible to specify simply the smallest features which can be resolved in the television image. There is an immutable interdependence between resolution and field of view. If, for example, the field of view is 432 mm (17 inches) or height enough to accommodate the image of a standard 14" x 17" roentgenogram, each horizontal line of video signal represents 1/525 of the total vertical image or 0.82 mm. Since it is obviously necessary to distinguish smaller details than this on a roentgenogram, some dogmatic radiologists have concluded that television cannot be used in roentgenographic interpretations. The fact is that much finer resolution can be achieved by reducing the size of the field of view. If a zoom lens is used on the television camera, it is possible to first view the entire roentgenogram, then to zoom in for a closeup of a feature of interest. Reducing the field of view so that its vertical extent is, for example, 140 mm gives an enlarged version of the image presented in this smaller area. The charge image on the television tube target area of a feature of this enlarged view is distinctly larger than in the overall view. In fact, each line of the video signal now represents 0.26 mm of the vertical image. The result is an acceptable resolution for even the most demanding radiologist."

Obviously, if satisfactory resolution demands zooming in on only a portion of the film, then one must move the lens to look at other areas of the film. According to the authors, this necessity is objectionable to some physicians. So, in answer to point two, the necessity for systematic scanning, the authors state, "Actually, it is also necessary to scan when reviewing a film directly in the conventional manner. Foveal vision in a single fixation between saccades or the jumps between fixations includes an area subtending only 2° at the eye. An angle of 9° has been suggested as optimum size for a fixed display.* In order to include the entire 432 mm vertical extent of 14" x 17" maximum format roentgenogram within 9°, the reading distance would have to be 267 cm, or over 109 inches. As a consequence, the finest details in the roentgenogram cannot be discerned. The usual reading distance of the radiologist is about one-fifth of this distance. Thus, standard practice in direct visualization of a roentgenogram is to adjust oneself for a close-up with a foveal field of view less than the size of the film. The result is magnification of the image of a detail on the retina, which corresponds to the television tube target. Finer details can be perceived in this manner. Scanning, so rapid it is thought of by most as a single glance or fixation, is accomplished by non-uniform saccadic eye movements."

"The practice of tele-radiology with simple equipment is straightforward. The radiologist will start, with an overall camera view of the roentgenogram, which is well adapted to searching for gross abnormalities. Having oriented himself, he will then use a zoom lens to scan systematically. It is important for the zoom lens to be under the remote control of the radiologist, and for him to be able to direct the camera at any portion of the roentgenogram. This method has been successfully used in one study of microwave transmission and interpretation of roentgenograms.** Since the scanning via the television camera is not as rapid as with the human eye, random, involuntary changes in the scan pattern which many radiologists believe they employ may be avoided."

"It is almost certain that a radiologist inexperienced in tele-radiology can review a roentgenogram in this deliberate fashion without any sacrifice in resolution or in his ability to interpret the shades of gray accurately ..."

"The question is not whether tele-radiology is preferable to direct visualization when either is available, but rather whether tele-radiology offers an acceptable universally applicable method to augment the usefulness of the radiologist and improve his accuracy. While clinical tests must be carried out to prove the point, in our opinion the answer to both is it does."

The fourth paper on roentgenology from Massachusetts General[7] urges the adoption of a method for comparing an X-ray reader's ability to recognize disease on direct view with the same or another reader's ability to recognize disease from viewing the transmitted image. In this paper, the test was the reader's ability to recognize tuberculosis from among a set of chest films which he had seen seventeen years earlier. The comparison was made by means of Receiver Operating Characteristic (R.O.C.) curves. An R.O.C. curve is a graph of the percentage of true positive reports versus the percentage of false positive reports made by an observer, in this case, a chest specialist.

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* By Tuddenham, W.J.: "Visual Search, Image Organization and Reader Error in Roentgen Diagnosis." Radiology. 78:695-704, 1962.

** See Reference 4.

The curves for this specialist were closely similar, as between direct and television viewing.

Additional tests involving two other physicians who reported roentgenographic densities both from direct and television viewing indicated that densities which lack internal structure or sharp margins are the most difficult to perceive via television. The authors state: "Easily performed improvements should make television interpretation as accurate as direct interpretation."

A current project (see Chapter IV, University of Nebraska Slow Scan) is devoted to study of roentgenographic interpretation using telephone lines.

Psychiatry

Participants in the Massachusetts General-Bedford Veterans Administration Hospital telemedicine project and the New Hampshire/Vermont "Interact" project have had considerable recent experience with psychiatric evaluation and treatment via interactive television. However, the first study of a psychiatric mode in telemedicine was made at the Nebraska Psychiatric Institute and University of Nebraska College of Medicine[8] in 1961. After describing the background and the technical methods employed in the group therapy project* this paper goes on to report the rated reactions of group members and therapists to both TV and non-TV therapy sessions. The groups were supervised by two therapists, each of whom ran four groups. Sessions of two of the groups were conducted by a therapist who was present only by interactive television; sessions of the other two groups were conducted face-to-face. The groups contained both men and women; group composition by diagnosis was determined by new admissions at the time a group was being formed.

Neither the group members' nor the therapists' ratings discriminated between television and non-television settings. Mean scores by group members of TV sessions and non-TV sessions were not significantly different. However, the group members consistently rated one therapist more favorably than the other, with a greater margin of difference in the TV situation than in the non-TV situation. No significant difference was found in the therapists' ratings between the TV and non-TV situations. In short, it appeared that the 2-way technique, per se, did not have a significant effect on brief group therapy situations, but the choice of therapist did.

The final report of the University of Nebraska to Norfolk State Hospital five-year project (1964-1968) confirms that results were favorable in all parameters observed: patient evaluation and therapy, in-service professional education, patient after-care and rehabilitation.

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* See Chapter II, University of Nebraska.

A paper based on the experience of professionals using the New Hampshire/Vermont "Interact" system[10] describes consultation services provided to non-psychiatric physicians to help them improve their knowledge of psychiatry and to treat their emotionally ill patients.

Local physicians in Claremont, N.H., were able to arrange psychiatric interviews for a wide, representative sample of their patients and to observe both patient and psychiatrist on monitors in a separate viewing room.

The authors conclude:

"Television has presented almost no difficulties as a medium for psychiatric consultation. It has not proved to be a significant barrier in establishing rapport with the patient or in perceiving emotional nuances. Patient acceptance has been impressively high. Even with a number of paranoid patients, the circumstances of the interview did not seem to produce additional anxiety nor has the TV system become the object of psychotic elaboration. Both patient and psychiatrist almost immediately lost awareness of the TV medium as they attended to the inter-personal business at hand. Only once—when a severely agitated patient paced unpredictably about the studio—was there a significant problem in keeping the patient in view. Relatively mild distraction has arisen from occasional deficiencies in the quality of the audio or visual signals. The system is operated solely by the participants, without need for the presence of a technician. Only five interviews have had to be postponed because of equipment breakdown. Thus the simplicity and reliability of operation have been gratifying."

"There have been indications that the physicians' experience of actually observing their patients' psychiatric interviews on the TV monitor has had a considerable educational impact—one in which non-cognitive learning is probably more significant than the acquisition of formal knowledge. This experience seems to dispel the mystery surrounding psychiatric work. It confronts their fantasies about what it means to interview psychiatric patients with a reassuring reality, and it provides an opportunity to identify with a person who is comfortable with such interviewing. It also gives them an increased sense of their capacity to do likewise."

"The doctors reported notable changes in their use and knowledge of psychotropic drugs. Whereas in the past their drug choices tended to be stereotyped, they now employed a wide variety of drugs, chosen more selectively and at more flexible and adequate dosages."

A report from the Department of Psychiatry, Massachusetts General Hospital and Harvard Medical School by Thomas F. Dwyer recounts his personal experience. It is not a formal study, but is interesting in that it represents the opinion of a professional psychiatrist who came to the interactive medium with prejudices about it that are typical of many medical professionals.

"I approached the use of television for psychiatric interviewing with grave misgivings; the majority of physicians lacking experience with this use of television have the same or comparable misconceptions. I was convinced that talking with a patient under the 'artificial' conditions of each seeing the other only on a television screen would deprive the interview generally of a sense of closeness and would *deprive me of a substantial number of skills available in an office interview.* To my surprise I discovered that the patient and I were in contact in the same short time that it takes when we meet in the same room. In the second and third interviews, I found many of the things happening that happen in any psychiatrist's office. From a patient who was potentially homicidal I learned (after more than a few minutes of uneasiness) that I could be as effective over television in redirecting his anger toward a more constructive solution as I could have been in my office."

"The patients from the start were less prejudiced than I. It seems probable that in some instances the patients were more comfortable talking to a psychiatrist by this means than meeting him in an office or clinic, a matter worth investigating since it bears on reaching a wider population and starting treatment earlier."

"By now I have presented observations on interactive TV interviewing to several small groups of psychiatrists who, without exception, expressed their conviction that one could not have the usual sense of personal contact with a patient over television. Some of this group have subsequently used the system to their complete satisfaction. It seems clear that whatever other factors may be operating in producing a strong negative response to the idea of a psychiatric interview over television, previous experience limited to watching passively an ordinary television gives an inept program model to compare with interactive psychiatric transactions. An M.I.T. engineer, present at one such discussion, asked a helpful question: Is a psychiatrist seeing a patient in his office confronted with more data than he can process? The answer is certainly Yes, and this raises an important issue. The psychiatrist listening with selective inattention has active control over what is not attended to. Does interactive TV screen out a significant portion of data available to the psychiatrist? My own impression is that any losses are more than offset by gains."

Questions about the effects of interactive communication on the structure of and relationships in a representative hierarchical universe of mental health workers and their patients will be identified in the project of the Illinois Institutes of Mental Health.

More studies in facilitation of work in mental health and psychiatry by interactive television are needed. Dwyer's provocative comment, "It seems probable that in some instances the patients were more comfortable talking to a psychiatrist by this means than meeting him in an office or clinic ..."[9] has not been subjected to study of such patient types nor the proportion of patients they represent.

A great deal of work has been done with television in psychiatry since the 1950's. Much of it has involved psychiatrists' study of videotaped therapy sessions and confrontation by patients with videotaped recordings of themselves. One must understand that there are differences between real-time two-way interaction (the subject of this report) and reaction to recorded visual and auditory material, as well as differences between presentation of clinical material and two-way interaction concerning the material. A respectable analogy to these distinctions would be attending a lecture as opposed to engaging in a dialogue with the lecturer. Both are functional, but they are fundamentally different, because of the feedback mechanisms they involve. The first is a passive experience for learners since feedback is limited to what the lecturer can pick up from expressions, etc. The second is active and total feedback is inherent to the process.

A compendium of information about uni-directional application of television technique in psychiatry is to be found in the book edited by Milton Berger.[12] This work reports a wide variety of uni-directional television modes and contains bibliographies on the subjects reviewed.

Mental Retardation

The first long-distance telemedicine project, linking the Nebraska Psychiatric Institute and the University of Nebraska Medical Center, both in Omaha, with the state mental hospital in Norfolk, Nebraska, 112 miles away, served mentally retarded patients as well as those with psychiatric disorders.

Reporting their experience[11] the principals noted that two-way communication provided expertise in psychiatric consultation for mentally retarded patients and guidance for the staff.

The state hospital was outdated and outmoded. Staff at the hospital, while competent to treat mental illness, "had neither training nor experience with the mentally retarded. They were consequently oriented toward little more than custodial care for them."

Initially, there was resentment by all levels of staff toward the distant Omaha psychiatrists in their "ivory tower." This, however, "lessened as the ... staff gradually understood that the television setup could help answer their questions concerning the treatment and management of the retarded."

The staff was first educated as to the special problems of the retarded and "the general informational, diagnostic, and treatment and management models ... for the mentally retarded individuals."

The shift from custodial to therapeutic care was crucial, but the staff "cautiously agreed to try. Soon they were most impressed by what the patients could do, and it became an increasing challenge [for the staff] to work out a specific program for each patient. This contagious quality of caring led to the consideration of such services as vocational rehabilitation, pre-vocational assessments, and plans for placement in community vocational and sheltered living settings."

With the exception of monthly one-day visits to the state hospital by the Omaha consultants, all contacts between the consultants and the staff were via the interactive television link, chiefly one hour a day three days a week but available 24 hours a day.

Significant changes effected by the television-facilitated project included:

"1. A positive change in attitude toward the mentally retarded ... The need for specialized treatment programming is understood at the applied level, rather than simply being stated as a noble or idealistic cause ... Improved staff function and intercommunication has definitely raised the morale of both the patients and the staff."

"2. Aides and orderlies are more concerned ... work closely with us on individualizing their care for each patient ... Many have commented that the job skills they have developed ... bring a sense of personal fulfillment ... The speed with which they ... caught fire with new ideas and ... techniques ... has been impressive."

"3. Adaptive abilities, rather than common multiple handicaps or intelligence levels, have been used to divide patients into subgroups."

"4. The large wards have been divided into smaller units by the arrangement of homelike furniture to form work, play, and sleep units."

"5. The elderly patients ... have been discharged to community nursing homes. Plans and details ... were discussed with the nursing homes and patients' families via ... television."

"6. This newly available ward space has been designated for ... mentally retarded patients from the immediate geographical catchment area. Younger patients are sought, and the goals of continuing their family ties during training and initiating habilitative vocational programs as early as possible are maintained."

"7. ...As they become aware of the vocational habilitation potentials in their patient population, the staff is more willing to engage the patients in creative activities and understands more fully the need for community sheltered workshop facilities."

The initial program expectations, it should be recalled, "were limited to custodial care, enforced dependency, and no rewarding work experience."

The authors concluded, in part, that "this experimental electronic consultative approach has circumvented many of the manpower problems of the state mental hospital ... The small professional staff had been attempting to direct patient treatment and management in an area outside their major knowledge and interests. Through the closed circuit television arrangement, the staff ... could work directly with a professional whose interests lay in ... mental retardation."

"It has also become apparent that this service ... has proved to be a reciprocal program that can help train psychiatric residents and other ... students by introducing them to the special problems and needs of mentally retarded inpatients ... and contemporary approaches to treatment and management."

Interactive television "opens new vistas for possible primary or secondary prevention of emotional disturbances in the mentally retarded, rather than the tertiary [custodial] approaches so frequently encountered."

"Finally, it should be stressed that this long-distance psychiatric approach was accomplished primarily with the nonprofessional members of the hospital staff. This consultative arrangement reaches the 'front lines' of patient care—the aides and orderlies—and motivates them to enlarge, improve, and utilize their repertoire of helping skills in aiding mentally retarded patients."

Speech Therapy

Formal, ongoing speech therapy for patients at Bedford Veterans Administration Hospital by a speech pathologist at Massachusetts General Hospital via the connecting telemedicine link was reported on in 1972.[13] Patients selected by the professional staff at Bedford were interviewed and evaluated via the interactive television link by the speech pathologist. Weekly or biweekly therapy was initiated via IATV. Patients were treated individually and/or in groups of not more than four patients.*

The majority of the 30 patients reported presented some degree of aphasia on examination. "In addition, however, patients with dysarthria, apraxia, dysphonia, dyslalia, stuttering and status post-larynsectomy have been followed."

Therapy on TV, followup therapy by Bedford personnel, and family counseling on TV were integral parts of the program. Several diagnostic tests were effectively administered using the interactive circuitry:

- Schuell Minnesota Test for differential diagnosis of aphasia
- Subtests of Eisenson's Examining for Aphasia
- Peabody Picture Vocabulary Test
- Articulation assessments via Templin Darley, Goldman Fristoe, Fisher Logemann test of articulation competence
- Oral peripheral examinations
- Iowa Pressure subtests
- Stuttering evaluations
- Auditory discrimination testing
- Voice evaluations
- Case Histories

Patients made adjustments to their communicative impairments by deriving support from others in group therapy settings, increased socialization and communication outside the therapeutic setting, and channeled their energies toward improvement in language functions and socially accepted behaviors, where communication impairment had led to anti-social behavior.

The author concludes, "The intimately personal nature of therapy is not reduced and, in fact, may actually be enhanced by IATV ... IATV permits an effective alternative to the classical, direct confrontation method of classifying and treating those patients presenting speech, language and voice disorders. IATV may even enhance face to face communication. Non-verbal communication is not only clearly seen and appreciated, but may also be augmented."

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* The television transactions were and are attended by the Director and Chief of Physical Medicine and Rehabilitative Service at Bedford, occupational and physical therapists on the Bedford staff, attending nurses, supportive personnel and members of patients' families. Professional and family attendees ordinarily observe transactions from a separate room in the Bedford telemedicine suite, unless their direct participation is desirable for the benefit of the patient.

Ongoing activities by the Massachusetts General Telemedicine Projects, in speech and hearing impairment among school children, include testing of speech sound discrimination which will be quantified on Receiver Operating Characteristic principles.

Another project which evaluated speech therapy via the New Hampshire/Vermont "Interact" system is reported in Chapter IV.

The new telemedicine project linking the resources of the University of Ohio Medical Center at Columbus to the Appalachian region, centered on Athens, Ohio will also include a speech therapy component. (See Chapter IV.)

Patient and Professional Acceptance

Patients encountering the interactive television medium have favored it overwhelmingly, in spite of speculation to the contrary by consumer advocates who foresee that disadvantaged patients, in particular, will view it as second-class care.[14]

The sole articulated patient objection discovered by the author was raised by residents of an East Harlem neighborhood in New York City who felt that substitution of a two-way television link would deprive pediatric patients at the neighborhood's Wagner Child Health Station of the attention to which they had been accustomed. Co-directors of the child health station would no longer be available, daily, on a face-to-face basis, but would be consulted via two-way television from Mount Sinai Hospital. These objections were resolved when it became apparent that contact with the co-directors was, if anything, enhanced, and that additional services, previously unavailable, were going to be regularly delivered.

A major study of patient attitudes sought to query all 343 patients who had been seen via interactive television at the Logan Airport Medical Station by physicians at Massachusetts General Hospital from November 1, 1968 to April 30, 1969.[15] The study was accomplished by means of comprehensive questionnaires which were accompanied by a covering explanatory letter from the Department of Social Relations at Harvard University. Additional correspondence and telephone communication helped to produce a final response rate of 80% (275).

This is a review of some of the findings of that study. The numbers used correspond to the numbers in the questionnaire. Often percentages cited will not total 100% because of the elimination of "not sure" and "no answer" responses. Questions 1-8 deal with experience prior to or apart from patients' encounters with telemedicine.

1. 69.8% of the respondents felt that medical care in the United States is improving.

2. 21.5% rated quality of care by physicians "excellent" and 64.7% as "adequate," with only 11.3% rating it as "less than adequate" or "poor." These responses refer to patients' attitude toward medicine in general.

5. In answer to the question "How satisfactory do you think most people would find the system of seeing the doctor over television?" 7.6% said it would be more satisfactory than seeing him in person, 30.9% felt it would be about

as satisfactory as seeing him in person, 41.5% that it would be slightly less satisfactory and 16.7% that it would be much less satisfactory than seeing him in person.

7. Again, trying to get at what may have been patients' attitudes prior to their own experience of telemedicine, in response to the question "How comfortable do you think most people are about seeing the doctor over television?" 12.6% felt that most people are more comfortable with the television system than with seeing the doctor in person, 42.2% felt that people are about as comfortable, 28.4% that people are slightly less comfortable, and 11.3% that people are much less comfortable seeing the physician on television than seeing him in person.

8. "How impersonal do you think most people find the experience of seeing the doctor over television?" 18.2 % felt most people find it less impersonal than seeing him in person, 30.6% "about as impersonal," 24.4% "slightly more impersonal than seeing him in person" and 16.4% felt that most people find it "much more impersonal."

Close counterparts of these questions were directed at the patients' own experiences with telemedicine:

9. (see 5.) "How satisfactory was your own experience in seeing the doctor over television?" Respondents indicated that 7.3% found seeing the doctor over television "more satisfactory than if I had seen him in person," 61.8% said it was "about as satisfactory as if I had seen him in person," 20.0% said it was "slightly less satisfactory," and 10.2% "much less satisfactory."

11. (see 7.) "How comfortable did you feel in seeing the doctor over television?" 9.5% felt "more comfortable than if I had seen him in person," 61.8% "about as comfortable," 18.9% "slightly less comfortable," and 9.1% "much less comfortable."

12. (see 8.) "How impersonal did you find the experience of seeing the doctor over television?" 15.6% found it "less impersonal than if I had seen him in person," 46.9% found it "about as impersonal as if I had seen him in person," 19.3% found it "slightly more impersonal" and 12.4% found it "much more impersonal."

The author notes, "If the study had been limited to a single question to access respondents' favorability to the system, one would have chosen item 13 [following] or something very much like it. This question has the advantage of linking attitudes toward tele-diagnosis with a concrete choice situation in which respondents might readily imagine themselves, and of having simple 'yes/no/don't know' alternatives for responses:"

13. "Will you recommend the television service to a friend with a medical problem like the one for which you saw the doctor over television (assume that the television service was about as convenient to use as any other.)"

69.8% would recommend it.
16.7% would not recommend it.
12.0% were not sure.

The responses to items 16 and 17 "rule out the possibility that the population using the system are self-selected by virtue of their prior attitudes toward it."

16. "Before you first went to the Logan Airport Medical Station, did you realize that there was a television system there?"
26.9% yes.
71.6% no.

17. "Before the time of your first television appointment, did you realize that you were going to be seen by television?"
12.0% yes.
86.9% no.

The study covers a number of other points, chiefly having to do with relationships between demographic factors and attitudes toward medicine, but no attempt is made to differentiate between these findings and those characterizing the general population of the region or the nation. The author concludes, furthermore, "In terms of prediction of attitudes towards the system, the results are mostly negative. Attitudes toward medicine in general account for about 10% of the variance in attitudes toward tele-diagnosis, but the effect of other variables is almost negligible. Education is the only other variable with an unambiguous statistically significant relationship— a negative one— to favorability to the system, and this relationship is very weak."* The author goes on to conclude, in part, that, "One might recall that the research was begun in some apprehension that there might exist a major body of latent antagonism toward the system, undetected by the Medical Station's staff. In light of the results ... I believe we can afford to discard such fears. About 15% of the population, judging from items 5-13 of the questionnaire, are real critics of tele-diagnosis, but no more. The possibility that the remaining 85% have strong critical feelings which they fail to express, seems to me very small. While the objections of the 15% must be taken seriously... through further research into the nature of their misgivings, one would hope... this rate of dissatisfaction should hardly discourage one from continuing to explore the possibilities of the system."

No formal study of physicians' attitudes toward interactive television in medical practice has been reported. However, there is ample evidence that the most virulent opposition to telemedicine may come from a large number of physicians.** Dwyer's opening comment about physician attitudes, quoted above, is characteristic. As a generalization, physicians who have heard about telemedicine but who have had no contact with it are at least skeptical about its effectiveness in accomplishing professional tasks and frequently denigrate the concept. Physicians who have had experience with the medium tend to temper their opinion toward more open exploration of its potentials.

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* It is noted that this relationship— inverse as between amount of education and degree of favorability to tele-diagnosis—"accounts for less than 2% of the variance of the dependent variable."

** See, in Chapter III, "Effects of the telemedicine medium on physicians' attitudes toward it."

Nurses may be expected to have attitudes about the medium which are related to their respect for physicians' opinions and their own motivations for greater responsibility in patient care. An unpublished manuscript 16 by principals of the New Hampshire/ Vermont "Interact" system showed that nurses interested in pursuing their education rated the medium higher when it was their sole method of obtaining continuing education than nurses who had other means for obtaining similar education.

46 nurses at the University of Vermont Medical Center in Burlington pursued a nine-week program of continuing education in the traditional fashion. They were lectured to by speakers in an auditorium. 33 nurses at the Central Vermont Hospital at Barre participated via the "Interact" network.

"At the end of the nine week series both nursing audiences were administered an attitude rating scale... to determine how they felt about the program as a whole. Both audiences were also asked to rank various methods of receiving medical education on a seven item list... to determine their respective hierarchies of preference."

"To better ascertain the role and utility of the interactive capability of the television, the nurses at Central Vermont community hospital were asked several questions directed toward interaction and participation."

"It was anticipated that both audiences would feel similarly about the program; however, those who learned via TV would rate it higher as a method of receiving education than those who learned face to face and were not dependent upon the medium."

"Results:

The ways in which both groups of nurses preferred to obtain their continuing medical education are shown in rank order in Table 2. (See page 174) As was expected the nurses in the community hospital who participated in the programs solely through Interactive Television ranked it higher than did the medical center nurses who participated in a face to face mode."

"The community hospital nurses' attitudes toward the TV and its interactive capability are shown in Table 3. (See page 175) Eighty-five percent indicated that they would not have participated more if they had attended the program in person. Ninety-one percent stated that they would not have participated further if additional microphones were available. However, when asked if they preferred to learn by TV rather than in person, 67 percent indicated the the 'in person' mode was preferable, but 76 percent felt that TV posed no obstacles to their learning."

"Discussion:

It is apparent that the medium made no significant difference in the attitudes toward the programs of those nurses who used the medium and those who did not use it."

TABLE 2

Burlington	Central Vermont
1. Formal Courses	1. Formal Courses
2. Local Hospital Programs	2. Interactive TV
3. Interactive TV	3. Local Hospital Programs
4. Journals	4. Journals
5. Audio Tape Cassettes	5. Audio Tape Cassettes
6. State Conventions	6. State Conventions
7. National Conventions	7. National Conventions

Table 2 shows the results of Nurses' preference rankings of ways they obtain continuing medical education.

TABLE 3

	Yes	No	No Answer
1. Would you have participated more if the microphones were more readily available?	2 (6.0%)	30 (90.9%)	1 (3.0%)
2. Would you have participated more if you had attended the program in person rather than over TV?	4 (12.1%)	28 (84.8%)	1 (3.0%)
3. Do you prefer to learn by TV rather than in person?	7 (21.2%)	22 (66.6%)	4 (12.1%)
4. Does TV pose any obstacles to your learning?	6 (18.1%)*	25 (75.7%)	2 (6.0%)

* Some of these obstacles were specified and are as follows:

Transmitting difficulties, difficulty in hearing certain speakers, and the camera not focusing on visual aids long enough for note taking.

Table 3 shows the numbers and percentages of Central Vermont nurses' answers to questions about the TV and its interactive capability.

"Secondly, it is apparent that these community hospital nurses who tried the medium like it, as evidenced by their ranking it second in seven preference choices ... The Medical Center nurses ranked TV third of their top three choices. An explanation may be that while the Medical Center nurses experienced minimal interaction over the TV, they were present and saw and reacted to the interaction between their lecturer and the community hospital nurses. Thus, they were able to rank the method in question from first hand impressions."

"Interpretation of the data in Table 3 regarding both groups' perception of the TV and its interactive capability is difficult. The question still remains as to whether or not technology introduces certain barriers to communication."

"For example, 18 percent felt that the TV posed such obstacles to their learning as 'transmission difficulties,' 'hearing certain lecturers,' and 'the camera not focusing on visual aids long enough for note taking.' It is interesting to note that 4 of the 6 individuals reporting such obstacles to their learning also stated that they preferred to learn in person. Also, it should be recognized that the nature of these obstacles is such that they can be corrected or eliminated now that they are known."

"Undoubtedly, the questions should have been more refined to prevent consequent ambiguity. For example, from monitoring the lecture series it is known that there was interaction between the community hospital nurses and various lecturers, although there was no attempt made to quantify this. Subsequently, when 91 percent of the community hospital nurses state that they would not have participated more if the microphones were more readily available, what does it mean? The authors suggest that possibly participation is basically a function of need and that additional microphones or in-person attendance is superfluous. In other words, the nurses participated because they felt a need for clarification, additional information, exploration of side issues, etc. and once this need was satisfied, there was no need to participate further, whether or not more microphones were available, whether or not they attend in person or via TV."

"It is interesting to speculate on the seeming paradox as to why the majority of the Central Vermont nurses preferred to learn in person even though they claim they would not have participated any more than they did via TV. Does attendance in person tend to reify the learning experience for them? In other words, does the physical act of first hand experience validate the image of the traditional teacher-student role? Vicarious learning, for psychological reasons, is felt to be second rate in spite of the fact that in many ways TV is better than first hand experience (e.g. boardwork may be seen closeup, volume may be adjusted, demonstrations may be seen without interference, etc.). It should be noted that this attitude is partially corroborated by the rankings in which formal courses, typically tradition bound in a lecture format, ranked just above TV."

"In view of the advantages of TV over the first hand experience of crowded lecture halls, far away blackboards, blocked view of demonstrations, one wonders over the validity of the belief (perhaps myth) that first hand experience is better than TV."

"In any event, it should be remembered that 33 community hospital nurses did attend this evening series with no apparent reward other than personal satisfaction derived from improving their professional expertise. They did choose to view the series over

TV rather than drive one hour to Burlington to attend in person. And finally, they were not awarded extra pay, equivalent time off, or academic credit for their effort."

"Conclusion:

The rapidly multiplying advances in medical knowledge and technology bring a concomitant increasing need for evaluating the traditional modes of disseminating this information and a search for other efficient and efficacious means of mass information distribution."

"Open circuit or broadcast television has been utilized in such a manner with rather marginal results. The results of the evaluation reported here with a closed circuit interactive system indicate a relatively strong acceptance of the medium by nurses as a means of continuing medical education."

Other Studies

Telemetry of electroencephalograph signals has been reported successfully accomplished over ordinary telephone lines. (See Chapter VI, Reference 6.) The author of this report is unaware of EEG transmissions using telemedicine links.

Study of the feasibility of transmitting stereoscopic images is underway in the Massachusetts General Hospital Telemedicine network. (See Chapter VI, Reference 5.)

Study of human engineering factors has been reported, in preliminary form, from Massachusetts General Hospital. (See Chapter VI, Reference 5.)

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CHAPTER VI

ISSUES AND QUESTIONS IN TELEMEDICINE COMMUNICATION

This chapter discusses some unresolved issues and questions in televised communication.

It is the view of all observers who have been consulted in preparation of this report that the most useful research should be conducted by interdisciplinary teams since sociocultural, economic, political, medical and technical factors are involved in purposive utilization of interactive television.

It is the author's contention that interactive television must be viewed not simply as a technology but as a medium of communication on the same general order as face-to-face communication, but endowed with constraints and capabilities different from those operating during face-to-face communication. Indeed, the means by which they facilitate performance are fundamentally different, and that difference influences not only the products of the interactions, but also the relationships among the interactors. If we attempt to analyze phenomena occurring as a result of telemedicine as if they were somehow isolated from the communication means by which they were produced we have not analyzed them at all. We have acted upon the insupportable assumption that means or processes of communication, either face-to-face or interactively televised, represent factors which either balance or cancel each other out. If they did balance or cancel out there would be no research to do! It is precisely because means are different that we see phenomena arising from the IATV situation which, in respect to the face-to-face situation, run gamuts from "like" to "unlike," "worse" through "same" to "better and most distressingly from "familiar" to "unfamiliar" and "ordinary" to "paradoxical."

This section is intended as a communication overview and preliminary checklist of some of the issues and questions that need to be addressed by researchers. *However, it is unrealistic to assume that further development of telemedicine will be dependent on exhaustive study, since health and medical organizations have decided that interactive television can facilitate the delivery of services now. Therefore an important research function is the development of reliable, useful information for those who are using or want to use telemedicine in the near future, as well as for those with longer-range decision and policy responsibilities at local to national levels.

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* For a further discussion of questions and issues in telemedicine see notably and foremost, a volume entitled "Telemedicine" edited by Rashid Bashshur, Zakhour Youssef, and Patricia Armstrong, published by Charles Thomas, Springfield, Illinois, 1974. This is a compendium of articles by social scientists, communication specialists, health care planners and technologists.

It will come as no surprise that most questions about telemedicine are interrelated. However, in what is still an early stage of exploration, two questions would seem to take priority over others: What functions in health and medicine can be performed satisfactorily via interactive television? and How is communication among participants accomplished in the interactive television medium?

There are some preliminary general answers to the first question. The second has not been studied. It is apparent that answers to the second question very probably will clarify answers to the first. Likewise, answers to both will affect answers to questions that follow.

Rashid Bashshur* makes a useful distinction between minimal parameters that define the existence of a telemedicine system and those which are important in considering the effectiveness of telemedicine programs. He categorizes four parameters as minimal conditions for the existence of a telemedicine system: geographic separation, telecommunication equipment, staffing arrangements, and organizational structure. Parameters affecting effectiveness, in Bashshur's view, "have been relatively ignored but deserve greater emphasis." They are: clinical applications and normative structure to guide behavior in the IATV medium.

What Bashshur identifies as "effectiveness features" are here regarded as of overriding significance for research. It may be that these features have been relatively ignored because they deal in coin from a realm where research has had little or no previous reason or opportunity to travel; thus research has developed insufficient knowledge of the nature of the marketplace, the goods therein, and the prevailing methods and rates of exchange.

From here on the priorities cannot easily be determined and they become a matter for decision by those who sponsor and perform research.

The major issues are:

- How does interactive television alter relationships among users?
- What is the impact of telemedicine on health and medical organization?

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* "Two additional parameters have have been relatively ignored but deserve greater emphasis are: (1) The specification of the type and nature of clinical applications first, in terms of the specific medical procedures that are amenable to the medium of telecommunications and second, the clinical ramifications of the loss of face-to-face contact between patient and provider and (2) the development of a normative structure to guide the behavior of all actors in the system including the physicians, nurse practitioners, physician assistants, patients, etc., and to mediate the division of labor in the system. The first four parameters listed above are to be regarded as the minimal conditions for having a system... without which there is no telemedicine system. The last two features are important in considering the effectiveness of operating telemedicine programs while minimizing friction that usually results from vague behavioral expectations." [1]

- How best can satisfactory access be provided?
- What should be the relationship of telemedicine facilities to larger telecommunication networks?
- What legal issues are involved?*
- What payment issues are involved?*
- How are factors of quality and access maximized relative to service requirements?
- At what point(s) can cost benefits of telemedicine facilities be meaningfully assessed?

Questions of cost, quality, and access arise at every stage of telemedicine implementation, from preliminary planning through each increment of application and expansion, either of services or facilities. Experience and understanding of divers telemedicine configurations will permit development of reliably tested models which will be appropriately useful for preliminary cost, access and quality analyses in a variety of projected telemedicine implementations.

Quality and access issues would seem to be related to the resolution of questions such as:

- What constitutes a satisfactory level of quality when the alternative is no care at all?
- Do consumers regard as unacceptable *any* system which deprives them of face-to-face professional care?
- How much access is the sponsoring institution or community willing to pay for in those areas where facilities are inefficient in comparison to those in more heavily-settled areas?

It is useful to separate questions about telemedicine into categories of "system" and "channel" as Allen Shinn[2] has suggested, in adapting the distinction from Alex Reid.[3] The channel is the communications hardware and the personnel who use it to communicate, and will be discussed in Section A of this chapter. The system is the organizational matrix into which the channel is set as will be discussed in Section B. Therefore the channel is what accomplishes the communication, and the system is not merely the network of channels but the health care system which it serves. Section C will deal with problems common to both channel and system.

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* No judicial review of any aspect of telemedicine, *per se*, has come to our attention, nor are we aware of scholarly work which attempts to assemble legal precedents applicable to telemedicine.

Payment for services received via telemedicine is likely to follow established patterns of the parent system. Although the question of a "telemedicine surcharge" has been raised, it has not been systematically applied. The big question is how third-party payors view delivery of services via telemedicine.

A. What functions in health and medicine can be performed satisfactorily via interactive television?

The functions considered here are those associated with diagnostic and patient-care management tasks common to medical practice.

It has been suggested by physicians and other professionals involved in health care that research be directed at facilitation of tasks. This is an almost impossible orientation for research since it would require trial and error for a very large number of tasks* each of which requires the exercise of one or more functions.

Instead, researchers should investigate how communication facilitates the functions, singly or in combination, common to all tasks or to discrete tasks. Where functions cannot readily nor feasibly be facilitated, then we should ask what is the nature of the information sought, in order to determine whether the information may be gleaned satisfactorily from other functions that are or can be facilitated.

If we eliminate patient interviewing and history taking the general functions associated with diagnostic and management tasks are four in number: inspection, palpation, percussion, and auscultation.**

Inspection subsumes all visual functions. We can eliminate from further consideration as presenting no significant problems of facilitation, the visualization of data gathered by indirect means (e.g. ECG, EEG, echo-sound displays, temperature, radiography*** or by photomicroscopy), because all can be specifically displayed. We can furthermore eliminate the visualization of gross parameters of physical examination (e.g. posture, physique, contour, chest expansion, motion) and, for all practical purposes, the gross appearance of smaller areas (e.g. scars, lesions, deformities).****

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* For example, there are plus or minus two hundred separate tasks which may be performed in a general physical examination. Additional examination tasks are performed in the specialties, while instrument-mediated diagnostics also add to the number.

** Functions of smell and taste are not considered here. The best the telemedicine clinician can do is attempt to elicit verbal information of these from the professional attending the patient.

*** Radiography is held to be the most complex visual image requiring interpretation by a medical professional. According to various studies, it can be accomplished satisfactorily. (See Chapter V and #13 in Chapter IV.)

**** This statement appears to be true if experience in dermatology is representative of facility in visualizing 2-dimensional appearance (e.g. distribution, morphology, relative size, degree of discoloration, ulceration, scaling, crusting, bleeding, suppuration) as opposed to 3-dimensional findings (e.g. texture, turgor, indentation, eruption, subcutaneous depth and extent). (See Chapter V.)

The inspection problems remaining include: Visualization of direct views of body orifices and the gastrointestinal and pulmonary tracts, assuming that instrumentation and trained personnel are available at the remote site,* mobility of field of view, comparison, and three-dimensionality.

The first problem, of directly viewing body orifices and the gastrointestinal and pulmonary tracts, presents three separate concerns.

First, in direct camera visualization of the intra-oral cavity, the camera, lights, and the remote hand with the attendent instruments are all in each other's way and remote controls have not been developed by which the distant examiner may move the patient's head. Miniaturization of equipment, precise remote control of patient, and precise routining of remote hand movements may be required. Alternatively to such routine, development of a servo-controlled instrument manipulator might seem indicated.

Second, in visualization by lens optics (e.g. opthalmoscopy, laryngoscopy, bronchoscopy, otoscopy, rhinoscopy, proctoscopy, sigmoidoscopy) the problem is to interface a camera lens with an optical instrument which is moved relative to the field of view. Thus, solution may lie in establishing the camera and instrument as a single unit which can be remotely moved.

Third, in visualization by other optics systems (e.g. fiber-optics), again, the problem is one of interface, since both camera and instrument must move as a unit. Interface is complicated where a fiber-optic bundle is involved because glue in the bundle appears as a visible grid to television cameras.

It becomes apparent that feedback must be considered. For example, the solution suggested for intraoral examination comes down to very complex manipulations of remote controls with or without an equally complex, precise and rigid routine that must be well understood, timed, and coordinated between two persons. We may have been led astray by the assumption that the feedback required by the physician must be delivered in the manner to which he or she has become accustomed in the face-to-face medium. However, in most instances inspection functions may be performed so as to deliver satisfactory visual information which is perceived to be "the same as" that to which physicians are accustomed. The further we pursue what is needed to facilitate functions, the more we will find that some functions cannot be readily facilitated in the accustomed manner but may be otherwise facilitated, as a result of discovering what it is the physician actually needs to know and the way in which the physician synthesizes the information given. Few studies to date have probed this area.**

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* Remote visualization of cardiovascular direct-view probes is unlikely in the very near future but cannot be ruled out if and when consultants communicate between major hospital centers.

** Andrus and Bird [4] have observed, after studying how radiologists scan an X-ray directly, that scanning with a remotely controlled camera is different. The radiologist using television will start with an overall view of the film. Then he will use a zoom lens to scan systematically (as opposed to nonuniform saccadic

To what degree can the remote physician's field of view be as mobile as if he were in the room with the patient? The movements to be reproduced are those in which the physician is moving laterally, vertically, or in depth, relative to the patient and vice versa, or when both physician and patient are moving relative to each other. Since the physician's point of view is that of the camera, is it more desirable to move the camera laterally and vertically or to move the patient? * How can the command of function that occurs face-to-face when the physician moves the patient and begins to use an otoscope or similar optical instrument be facilitated?**

W. Scott Andrus and Kenneth Bird have given the problem of mobility considerable thought:[5] "Although much of the inspection required by the professional can be done by positioning either the camera or the patient, such manipulations introduce an unnecessary degree of awkwardness. Several suggestions have been made to increase the versatility of the remote control camera by providing a circular track surrounding the patient at a distance of several feet. By adding rotational movement along the circumference of such a circle,satisfactory visualization of virtually every portion of the body could be achieved. An overhead camera with x-y mobility would also be helpful. Instead of the floor tripod for the various cameras used to supplement the primary camera, an overhead mount with fingertip control to move and point the lenses for sharply focused images will be a real technical contribution.

"Macrophotography will enhance the usefulness of virtually any patient service-oriented telemedicine system; for example, tele-otoscopy is being explored within the Telediagnosis system. All of the technical factors and complexities which bear on the actual picture-making process must be minimized to prevent alteration of the

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eye movements used when scanning the film on a view-box.) "Since the scanning via the television camera is not as rapid as with the human eye, random, involuntary changes in the scan pattern which many radiologists believe they employ may be avoided."

"It is almost certain that a radiologist inexperienced in tele-radiology can review a roentgenogram in this deliberate fashion without any sacrifice in resolution or in his ability to interpret the shades of gray accurately. With slight practice, he will be able to interpret roentgenograms as quickly via television as on direct viewing. It will be necessary for him to learn new habits. A more systematic scan pattern is necessary. Since a systematic search pattern is said to be best, perhaps interpretation will improve when such a pattern actually becomes necessary."

* A fixed camera provides depth approximation of the physician's view by zooming and his/her head movements by panning and tilting.

** It would appear that use of instrumentation would have to be anticipated at the remote site. A basic kit of optical scopes, turret-mounted on a camera and comprising a basic unit, could be developed and permanently mounted on the examination table.

patient's perceptions and expectations of telemedicine. If the technical performance is allowed to intrude, then patient acceptance will be decreased. There is every need to reduce the diversionary aspects in the diagnostic, consultative, or functioning process. Related to this need for macrophotography and the desire to render optimum close-up photography is the possibility of providing several degrees of motion in the examining table upon which the patient may sit or lie. A modification of e.g. latest type of dental examination chair which has up-down, rotational and folding-unfolding features could serve as a prototype. By combining easy camera mobility with the additional mobility offered by such an examining table with a focusing and illumination feedback control device, the needs of telemedicine would be met in this area."

Development of very small camera equipment is now in progress and utilization for telemedicine should be tested, to further remove the "diversionary aspects" Andrus refers to, as well as to enhance mobility. In the same vein, utilization of wireless microphones could provide greater mobility to both nurse and patient at the remote site. The nurse in particular must often move out of range of a fixed microphone.

Comparison is a function television can readily accomplish, given the proper equipment. Comparison is feasible among as many camera outputs as are available and can be activated at the examining physician's location. For example, if the physician wishes to see a view of the patient's right leg from knee to ankle, an X-ray of the same leg and a microscope slide of biopsy taken from the right tibia, simultaneous camera outputs may be reviewed by: switching from one camera to another; display of all three outputs on a single screen simultaneously by a process generically known as "matting;" display of a static X-ray and slide using a 2-channel videodisc recorder or frame-grabbing scheme, on two monitor screens in addition to the "live" shot of leg on the usual monitor; or a display of all three as "live" outputs on three separate screens. *

Three-dimensionality may be achieved by use of stereoscopic lens devices. These are undergoing testing at Massachusetts General Hospital. They should be examined in other locations with different applications to determine their effectiveness in conveying satisfactory information of "depth" over the entire range of views which various cameras and lenses make possible. Holography, actual three-dimensional visualization, has not yet been perfected. When it is it will have considerable potential for telemedicine.

Palpation

Direct palpation, which requires the "laying on of hands" obviously is not currently feasible in telemedicine. The functions of palpation may be achieved, with varying degrees of success, by obtaining information from the professional in attendance with the patient while some palpation functions may be performed by indirect means.

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* Since this requires three television channels, it probably is impractical at this time.

Direct palpation involves all the functions of the sense of touch. Can some touching functions, such as temperature, presence of moisture, and resiliency (noting the time it takes for edematous tissue to assume its prior state) be reported by indirect means?

Which touching functions may be satisfactorily reported by a professional in attendance with the patient? This question cannot be answered objectively. Factors of training and competency of the attendant, previous experience shared by the participants, degree of finesse required, all enter into the ad hoc subjective evaluation. Generally, it would seem that this type of report is usefully limited to gross differentiation, unless the reporter is a physician with a command of precisely descriptive language.

Which touching functions may submit to satisfactory indirect report as the result of development of technology? Servo-controls to replicate hand and finger movements are in common use in laboratories where contamination of materials or injury to the performer would result from direct contact. Some of these give feedback of the pressures that are being applied to the object grasped. The heart motion amplifier, a device in fairly common use for medical education, delivers a gross report to the hand by means of a styrofoam pad, of the rising and falling movements of the heart over which a device has been placed. It moves with the heart and is motion-sensitive only. Devices incorporating principles of the above types, to report to a distant hand motion and textural phenomena encountered by a mechanical, electronic, or sonic probe can be developed, if they are not already in existence. When such devices are available there should be no problem in transmitting the information via any of the means used in transmitting television.

Which functions can be converted to other functions? For example, which palpation functions can be converted to inspection functions? Andrus and Bird[5] point out that among the many functions of palpation are the demonstration and delineation of abdominal masses, abnormal liver and spleen enlargement, cysts and lymph node clusters and the like. Although a physician may insist he must perform palpation for these reasons, "yet his needs might well be satisfied by an appropriately designed ultrasonic transducer which would permit even more accurate examination albeit with a technique about which he currently knows very little." Are there functions of palpation other than determinations of location and extent that can be accomplished by other means?

Percussion

Percussion consists of both touching and hearing functions. Sharp finger taps produce tones characterized as dull, flat, sharp, resonant, hyper-resonant, tympanitic, etc. Like auscultation, it merely provides indirect evidence. The functions of percussion may be achieved to varying degrees of satisfaction if the professional in attendance with the patient performs the percussion under the distant physician's view. The professional performing the percussion must be not only skilled but consistent. The finger taps must be either uniform in intensity or graduated quite precisely, if they are to produce tones which can be "read" with any degree of accuracy. The microphone always should be the same one and placed at the same distance from the sound source. This distance should be fixed as a result of testing, and volume, once established, likewise fixed. "Turning up" the volume introduces a higher degree of ambient sound pickup, often an effect of greater resonance. *

Certain percussion functions may be converted to other functions. For example, when percussion is used to detect cardiac enlargement or pleural fluid accumulation, Andrus and Bird[5] suggest means may be used similar to those suggested above, under Palpation. An ultrasonic transducer would produce a visual read-out of location and extent of mass, or "constant tone auscultation, in which a steady pure tone sound** is introduced into the body and a stethoscope is used to study transmission." Development of the latter device could, pending study, deliver information of changes at and between interfaces. It would require the physician's learning a new technique, but would facilitate face-to-face functions as much as interactive television functions.

Auscultation

Auscultation is used to ascertain sound functions of heart, lung, and bowel. From sound functions, deductions can be made as to conditions in the organs examined. Thus auscultation, per se, is a means of obtaining indirect evidence. Auscultation functions may be accomplished satisfactorily in telemedicine. The use of an electronic stethoscope permits the distant physician to hear auscultatory phenomena as if he or she were present with the patient, under the following conditions. The physician must have a good view of the placement of the stethoscope. Control and placement is effected by instruction to the attending professional. The physician either must learn to interpret the sounds delivered by the electronic stethoscope (sound frequencies up to, and capably beyond 10,000 cycles per second) or the instrument's output must be degraded to the range of the acoustical stethoscope the physician is accustomed to using. ***

Which auscultation functions can be converted to other functions? Generally speaking, it is apparent that auscultation functions, like inspection functions, are capable of being accomplished in telemedicine. Consequently, the motivation to seek alternative means of obtaining the information auscultation provides may be less than the motivation to find alternatives to palpation and percussion. It must be observed, however, that some auscultation functions already are performed by other means, except those requiring the use of radiologic and exploratory techniques which expose the patient to potential danger. Phonocardiography is a sophisticated technique not yet widely used, although it allows greater diagnostic precision. Telemedicine can deliver phonocardiography in very short time to a great distance. Instrumentation which precisely quantifies lung and abdominal sounds is unknown to the author.

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* Development of a spring-loaded percussor with microphone pickup would be fairly simple and would eliminate the variables.

** From a tuning fork or, better, an audiometer.

*** Concurrently, studies need to be performed to assess the utility of the greater amount of information delivered by the electronic stethoscope when its output is not degraded. Is the additional information of significant diagnostic value? How readily can this information be assessed? How easy is it for physicians to learn to use it? Is the diagnostic increment worth the trouble?

Ease of operating controls. It is apparent that most inspection and auscultation functions can be accounted for, currently or potentially, in the interactive television medium. Whether functions can be performed satisfactorily depends not only on probing the potentials of telecommunications technology, but on developing easily operated mechanisms for control of equipment at the remote site.

If sophisticated technology cannot be handled by any participant after a modicum of instruction, telemedicine will either be viewed as too complicated by many or will become the preserve of a new specialty of telemedicine practitioners. The second alternative is undesirable because one of telemedicine's primary goals is to provide access to professionals who have medical skills, not technical operating skills.

The first types of studies that need be done to guide development of easily operated control mechanisms are studies of information requirements. Andrus and Bird[5] put the problem well: "One problem facing the engineer who is capable of imaginative design and application of existing knowledge is that he may be unable to communicate with the physician who presents him with a list of specific demands rather than defining actual medical needs."

The engineer's plaint is only one side of the problem. The other side is that physicians often may find it difficult to analyze the nature of the information needed which can be met by the application of ordinary techniques. Consequently, it may be fruitful to analyze the physician's information criteria in terms of their content and sequence.

Second, studies are needed which attempt to match ascertained informational needs to appropriate technological responses. Andrus and Bird[5] note that, "To estimate the severity of failure of the circulatory system, the best measurement may be a combination of skin temperature and simultaneous body core temperature." Yet such a solution "is most unlikely to develop from any of the early engineer-physician dialogues."

Finally, human factors studies should be undertaken. Given an array of telecommunications technology the design of which is as responsive as possible to well defined information needs, we are faced with the question of how it is best controlled remotely by the physicians who must use it.

Ideally, all three issues are addressed simultaneously so as to give some opportunity for interaction between what is desirable and what is feasible.

The equipment required to facilitate simple remote control, even of ordinary fixed-mount cameras needs still to be assayed for telemedicine use. Currently, physicians are provided with a joy-stick which pans and tilts the remote camera on an x-y axis. A double row of six buttons provides the other controls (one to zoom in; one to zoom out; one to focus forward; one to focus back; one to close the lens iris, and one to open it). To zoom in from a wide view to a small dark spot requires a complicated set of maneuvers. Simplification of remote camera controls could be accomplished by a single spherical control held in the hand. A complete range of movement in the plane of the remote lens would enable the physician to select any field of view, push-pull to zoom in and out, revolve the sphere for focus, and revolve the ring at base of

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the sphere for iris control. Another type of control could be a pencil-like device, emitting a point of light, which when touched to the physician's monitor commands the remote lens to zoom in focus to the area touched, controls the distance of zoom by removal of the pencil; zoom out would be controlled by a switch emitting a different frequency of light, and change of field of view by moving the monitor, itself, the patient, or other object, relative to the position of the remote camera lens.

Positioning the patient relative to the remote camera lens is currently a clumsy operation requiring the person in attendance to either move the patient or the examining table, according to the physician's verbal instructions. Andrus and Bird suggest an ingenious approach to this problem: Provide the physician with a small model of the examining table, with electronic linkage, so that movement of the model would produce a corresponding movement in the remote examination table. Furthermore, a flexibly mounted camera could be similarly linked to a model. With a bit of practice the physician could move the camera and the table to desired positions.

Problems associated with movement of camera, light, head position, and instruments during an intra-oral examination could be alleviated by remotely controlled servomechanisms. Optical instrument units could be similarly controlled.

In applications where the physician manipulates more than one element, he or she will need to see not only the output of the camera which conveys the desired information but also the output of a second camera which allows visualization of the spatial relationships between the various elements that are being manipulated. The requirement of a second camera again raises the issue of the manner in which outputs of the two cameras may be simultaneously compared.

Control of placement and movement of instrumentation on or near body surfaces (for example, electronic stethoscope, transducers of various types) could be accomplished by means similar to those suggested for camera and patient movement. Such remote controls would be useful on locations where skilled professionals are not attending the patients.

Are there instances in which functions do not require the full television bandwidth? Since standard transmission of a television picture and sound in real-time requires 6 MHz of bandwidth (6,000,000 cycles per second) 6 MHz represents a basic electronic resource—the full standard television channel. Someday the transmission resources will become scarce as more people wish to use the medium than time will allow. At this point, time-sharing will become necessary, and it may be required that transactions be confined within a certain number of minutes. This scheme defeats the system's purpose by allowing use only for transactions which can be accomplished quickly. A better alternative would be to share the bandwith. Bandwidth-sharing is also called time-sharing.*

How can bandwidth sharing be accomplished? If a lesion need not be seen by a moving camera, or in motion and the physician is prepared to wait a few seconds between pictures, it may be viewed in a single still frame or series of frames via "slow-scan." This uses only 2,000 to 15,000 cycles per second. (The greater the number of cycles per second, the faster the rate of transmission can be.) A "frame-grabber" (refresher) which uses the whole bandwidth for a thirtieth of a second but sustains the image as long as it is wanted is another potential device for time-sharing. The same devices can be used for viewing X-rays. The physician must request closer views by referring to points on a standard grid. This equipment is useful in all instances when all there is required is a static picture or a static view through a scope.

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* See Appendix B for a discussion of time-sharing technology as it relates to cable television.

What information can be transmitted via telemetry? The electrocardiagram (ECG) in particular is often viewed, not from a paper print-out, but on a cathode-ray tube. The TV screen gives a superior cathode-ray display while bandwidth requirements may be as low as 20 KHz. The electroencephalogram (EEG), unlike the ECG, cannot easily be read as a continuous "live" flow of running information. Neurologists insist on reading the paper tracing. Data from the EEG's standard 8 leads, however, can be transmitted as a set from one electroencephalograph to another, which then provides the required print-out.* Bandwidth requirements would be in the range of ± 10 KHz.

Patient records stored in computer memories may be transmitted as alphanumeric data. Bandwidth requirement is variable, depending on the speed of transmission and the size of the characters transmitted.

When the physician is viewing a still picture such as slow scan which may require discussion or questioning, or whenever sound is a component of the transaction, audio circuits will be required. This adds 20 KHz 20 KHz of system bandwidth in each direction. In cases of telemetry, alphanumeric data and computer requests, voice communication will not be required.

How is human communication accomplished in the interactive television medium? Chapter III of this report, "Human Communication in the Interactive Television Medium," establishes that the interactive television medium is different from the face-to-face medium and suggests some of the parameters in which differences may be observed. For example, it describes constraints imposed by the character of the images and sounds which present information of the distant space and the actors in it, norms or codes of behavior appropriate to settings and role concepts, and perceptions of distance requirements. These are interrelated constraints imposed by the nature of the medium, about which little is known.

Research aiming at predictions of behavior or quantification of outcomes of behavior in IATV will be of very low reliability until we understand how interactors perceive where and who they are in relation to the job they are there to do, as well as their relation to the rest of the people who are also involved. No disrespect of the methodologies of prediction nor quantification is intended. Indeed it is suggested that the conditions necessary to the application of such methodologies do not exist. One must know whether the game is being played on a football field or a chessboard before predicting the winner or the final score. Productivity can not be assessed reliably where the process is not understood.

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* Donald Bennett, M.D. of the Department of Neurology at the University of Utah College of Medicine in Salt Lake City has experimented since 1968 with transmission of EEG's in this manner via ordinary voice-grade telephone lines. Currently, all 8 EEG channels are transmitted with resolution satisfactory for many diagnostic applications. A major exception is evaluation of cerebral death.[6]

Instead, early observational research should be conducted at sites where telemedicine already is being explored. Laboratory research often implies that participants engage in role-playing (in the sense of psychodrama as opposed to real-life role-playing). One of the objectives of research would be to discover what are the roles people assume in telemedicine, thus laboratory experiments dependent on a reasonable definition of roles would appear to be premature.

The temptation to narrow the scope of observation should be resisted. Concentration on observing that which the observer feels can readily be assessed rules out what cannot readily be assessed. Yet what cannot be readily assessed may be more significant than what can be readily assessed. To the extent the IATV medium differs from the face-to-face medium we must be prepared to accept that it may present us with communication phenomena that have not been considered or infrequently observed in studies of face-to-face interaction. At present we have only the broadest indications as to what we are looking for in observing the participants' perceptions of frames and roles, role behaviors and underlying attitudes, and the functions of interaction.

At a representative and accessible site observation may be accomplished by in-person case-study and from videotapes which preserve what participants saw, heard and did, on-screen. Formal and informal interviews would preserve participants' differentially-scaled attitudinal responses as well as more detailed responses to questions about their attitudes during transactions.

Adjustment of the setting, equipment or the performing participants behaviors is necessary in order to produce change in the direction of improved performance. It is impossible to state precisely how such adjustment should be brought about. The primary criterion for any adjustment is that it facilitate what the participants already are attempting to do or what they want or perceive they need to do. Adjustments imposed by the research team would proceed in discrete increments acceptable to participants and would be fully discussed with them prior to initiation. No adjustment should be contemplated until the research team is thoroguhly familiar with the situations it is observing, at which time other criteria would become operative. For example: Are participants consistently having difficulty in performing a particular function and can that difficulty be resolved by making an adjustment? Is such adjustment feasible within the limits imposed by the technology and the overall working arrangements of the staff of participants? Have some participants made behavioral adjustments which are unknown to or unrecognized by other participants, and might such adjustments be of advantage to other participants in their own performance?

Analysis would include evaluation of: macro and micro observation of videotapes of "on-screen" behavior; notes of "off-screen" behavior; formal and informal interview data; socioeconomic data per participants; and efficiency and effectiveness ratings by participants and non-participant observers (health care professionals).* Conclusions could be summarized by narrative description of observations in case-study form and/or correlations among selected variables. Although coding criteria will be evolving during the course of research from the researchers' own interactions and experiences, nevertheless, final determination of what is to be coded and in what manner, should await reflection and have the benefit of consultation from other experts.

B. What is the impact of telemedicine on the relationships among professionals and clients in a health care system?

Interaction within the telemedicine channels (in terms of perception of activity frames, role concepts and behaviors, the functional content of televised interactions) has been discussed. However, another order of affect may be seen in the relationships in the overall system of health care in which telemedicine is incorporated. Here we would look at relationships in terms of the development of functional patterns. Some patterns would extend across the telemedicine channels; some would be totally outside them and, in many cases, some patterns would operate totally inside them. It is difficult to envision a situation in which such a system's patterns would not comprise all three contingencies, nor one whose patterns would not be affected by telemedicine to some degree. Consider, as examples, the impact of the following:

Patterns developing inside the telemedicine channels:

1. referrals via telemedicine from remote physicians to medical center specialists. To whom did physicians previously refer? How often? Were physician and consultant accustomed to the other's presence during consultations? How do they now refer differently?

2. referrals via telemedicine from remote nurse practitioners to central physicians. To what extent did the physician previously rely on nurses or other non-physicians in his practice? To what extent does the nurse practitioner reduce or increase the physician's responsibilities?

Patterns developing across the telemedicine channels:

1. televised meetings between physicians at remote and central locations. How much correspondence, telephone interaction, and face-to-face interaction is facilitated or reduced by "meeting," "observing," and "working with" via IATV?

2. consultations leading to the transfer of patients to the direct care of the consultant. The specific experience of Mount Sinai in New York is relevant in that patients from East Harlem who ordinarily will not go to the hospital for care, go readily to see "that doctor I talked with on TV."

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* Participants' performance ratings may be compared with non-participants'.

3. transactions which save significant amounts of professional time. What effect does this have on the professional whose time is saved?

Patterns developing outside the telemedicine channels:

1. decreased pressure on outpatient and emergency wards. What effects are introduced in terms of time spent on diagnosis and treatment and on relationships with patients?

2. incorporation into the system of techniques that arise from telemedicine. Telemedicine for primary care mandates use of non-physicians, and suggests central files of patient records. What happens to relationships with physicians when nurse practitioners are employed in non-telemedicine clinics? What changes in personnel relationships occur when patient records are centrally-located?

Affects on relationships created by the integration of telemedicine within the system would seem to be susceptible of quantification.

Questions of how often? how much? how many? etc. can be devised to examine impacts on the relationships. Sociometric information flow models may be useful to determine patterns of communication. (See Chapter IV, #6).

What is the impact of telemedicine on the organization of a system of health service?

It has been suggested by Bashshur[1] and others that the adoption of telecommunication technology can be expected to significantly alter the traditional mode of medical practice. Physicians who have been practicing in relative isolation will probably experience a greater degree of change than those operating in groups or as members of hospital staffs. On the other hand all professionals using telemedicine facilities will have greater and more rapid access to other professionals and facilities.

Once televised interaction becomes efficient, the productivity of professionals in a telemedicine network should increase as the individual activities of the various actors in the system are differentiated, their specific tasks become routinized, and their activities become rhythmic. Under these conditions the system configuration may assume a greater complexity that enhances its productivity both quantitatively and qualitatively.

"Finally, the effects of telemedicine on the system as a whole are suggested by the effects on recipients and providers of health care. Specifically, innovations in communications technology could alter both the receipt and provision of health care. The facilitation of real-time interactive communication, monitoring, and control among providers of differential skill levels and with a broad set of specialties, could alter the organizational and behavioral configurations of health care delivery. By permitting reallocation of functions, a redefinition of the scope of activity, and a reduction in waiting and treatment times, telemedicine has the potential to increase the productivity and thereby reduce the costs of the delivery organization; by facilitating real time access to patient, diagnostic process, and optional therapy data banks, telemedicine has the potential to increase the quality of care; by enabling the often physically separate yet functionally interrelated providers to partake in information sharing within a network, telemedicine has the potential to reduce if not eliminate system fragmentation."[1]

Before telemedicine exploration had spread beyond the three pioneer projects, Kas Kalba* suggested that, "The hospital of tomorrow will not be a building but a configuration of services [which would comprise a] multi-layered and physically dispersed system of health-care delivery" facilitated in great measure by tele-communications technology.

System models

Discussion of the impact which telemedicine will have on the organization of a system of health services comes down to the configuration of the system. Models or configurations of health systems incorporating services, communication patterns, and organization, and including geographic and economic factors as well, are needed. Problems arise when one attempts to assess the changes wrought in models by the introduction of interactive television technology.

We can with some considerable accuracy predict the costs of providing links of various levels or degrees of technological capacity among a few or all of a number of locations. But we have little information about human communication capacity, behavioral/attitudinal patterns, or quality of performance associated with various levels of the technology. Lest we be surprised in the act of fitting out the model with fractions of fact, how can we deal with this caveat?

The matters about which we have little information go to answering the questions:

- Which of the services required by the model can reliably be performed per level of technological capacity?
- How much time is going to be required on the average for performance of each of the services which represent, say, 85% of the total number of transactions?
- What are the staffing requirements for each of the services that can be performed?
- How are patterns of patient flow affected? How many new patients are introduced to the system? Where are the patients going for care and what are the time factors involved, per service performed?
- What functional patterns are developed in the relationships among participants?

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* We have quoted Kalba somewhat out of context. He is in mid-discussion of the possibilities for health service delivery via community cable systems. Nevertheless, his remarks are apt and remain timely.[7]

- What types of unanticipated functions are developed in the telemedicine setting? What new demands do they create? What do these demands imply, in terms of staff and allotments of time on telemedicine channels?*

One must look at the impacts of telemedicine on the system over time, on the assumption that the system is a process affected by forces from within and without. Therefore it is desirable to design system models which can reflect changes and trends over a period of time prior to incorporation of telemedicine. It is difficult, given the inadequacies of current data about telemedicine, to suggest how idealized in vitro models could be kept abreast of trends and of changes. However, when reliable data on telemedicine does become available, such models may produce insights of increasing validity.

For the present, there would seem to be considerable value in periodically gathering data on actual health systems where telemedicine is later going to be introduced. These prospective studies could show the actual impacts of telemedicine when it is introduced. Furthermore, it might be possible to show how impacts change as the telemedicine concept becomes better understood by users.

C. How much access is enough? What is the maximum number of locations that can be utilized?

Perhaps the major claim for telemedicine is that it can redress imbalances in the delivery of health services by providing wider access to resources in patient care and professional education. For simplicity's sake this section will be concerned with the access issues that are involved in care.

How should access be provided by a telemedicine facility serving a specific geographic area, regardless of size or demographic composition of that area? Each community should determine the extent to which a redistribution of resources via telemedicine would provide greater access, and should determine the precise nature of that redistribution. Gary Shannon [8] puts this requirement in its geographical perspective:

"The notion of accessibility implies an observed or defined functional association or interaction among objects and a degree of separation or distance between them. The impact of distance upon accessibility varies with the association under study. Accessibility of a potential patient to an IATV unit, for example, decreases with increasing distance from the unit. Thus we would expect a 'distance decay function' to describe the decreasing accessibility to the health facility with increasing distance from the unit...

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* For example, socializing functions may be the glue that keeps isolated professionals in the system. Shinn notes this possibility: "I think it is at least arguable that a major use of TV systems, especially in rural areas, will be to keep remote practitioners sufficiently in touch with their professional and social peers so that they do not feel overly isolated."[2] Facilitation of previously non-performed functions may create new demands. Physicians using the Lakeview Clinics' telemedicine facility reported a number of instances where they monitored patients in the hospital delivery room, and newly-admitted patients about whom they were concerned.

"It is of particular importance to telemedicine research and planning, to know how well an existing distribution of health facilities serves a population and distinguishable sub-groups of that population, and the extent to which various recognizable subsets of medical facilities including IATV units, serve a population. It is also of major interest to measure the impact on accessibility of any proposed change in the location and/or level of health services through the introduction of IATV."

Shannon goes on to note that, "The level of services to be provided by telemedicine will vary both by the professional level of the supervisory personnel at the remote IATV unit and the data information system and consultant personnel available. A remote IATV unit staffed by a general practitioner, for example, will provide a higher level and greater range of services to a patient than a unit supervised by a nurse practitioner or physician's assistant. That is, there will be a hierarchical distribution of services available within the IATV system not entirely unlike the hierarchy of services available within the hospital system as it now exists. Major teaching research hospitals provide a greater number and more sophisticated level of services than do regional hospitals, community hospitals, etc."

Acess as a function of distance from a particular type or level of service is, as Shannon points out, based on the assumption that the service is available if one travels to where it is dispensed. Access becomes further defined by the hours of the day and the days of the week that service is available.

Using Shannon's observations as a starting point, we can ask:

- Assuming telemedicine is to facilitate care to those in the total population who are currently under-served, what and where is this population?
- What is a reasonable distance beyond which travel approaches the degree of difficulty currently experienced by these patients?
- How many telemedicine outreach clinics are required and at what specific locations, to meet the needs of the under-served population?
- How many hours per day and days per week must the clinic(s) be open for service, given the numbers of patients served and the varieties of service provided?

The above questions assume the necessity of providing service at ideally located new clinics. Obviously a quite different situation prevails when some or all of the service is to be provided at existing but currently substandard locations or when geographical barriers, such as mountains, would interfere with transmission to more desirable locations. It is at junctures like these that the planner is faced with the decision to compromise desired efficiency in terms of numbers well-served in favor of providing some service to fewer patients.

Frequently overlooked or underrated is access to telemedicine stations in the hospital by professionals, particularly physicians. However, we should ask:

- Where are potentially participating physicians' other hospital duties performed?
- What is a reasonable or tolerable amount of time to expect a participating physician to spend in transit to and from other duty stations to a telemedicine station?
- How does hospital physician transit time affect waiting time, queues, and professional time requirements at the remote location?
- Where and how many telemedicine stations should there be in the hospital?

Access is limited by the services that are offered. Thus access is affected by the presence or absence of personnel and facilities to take and develop X-rays, to perform laboratory functions and demonstrate photomicrography, etc. at the telemedicine locations.

What are the technological requirements for an all-encompassing facility?

Instead of asking, "What is the minimum number of locations required?" let us now ask, "What is the maximum number of locations that could be utilized?" Would it be useful to provide two-way connections in places such as:

- physicians' offices?
- patients' hospital rooms, surgery, ICU-CCU, emergency wards, laboratories, pharmacies, conference rooms, administrative offices?
- schools, factories, day-care centers, nursing homes, and places where large numbers of people gather, such as shopping centers and sports arenas?
- homes of patients requiring post-hospital monitoring, physical and other rehabilitative therapy?

In discussing minimum locational requirements, we have been recognizing constraints imposed by the technology currently in common use for telemedicine. Most current telemedicine is based on point-to-point distribution, whether by microwave, cable, laser, or other means. Location A ⇄ Location B. Location A ⇄ C. To interconnect B and C, transmission is routed through A, but if A cuts into the channel, both B and C may interact with A but not with each other.* If A uses the same channel to reach both B and C, and both B and C use the same channel to reach A, then B and C cannot interact at all.

---

* This is oversimplified, to be sure, but makes the point well enough. In fact, it is possible to have separate interconnects A ⇄ B, A ⇄ C, B ⇄ C. Note we have used six separate television channels, which would appear to be an excessive dedication of bandwidth in most situations.

In order to bring large numbers of locations into the telemedicine network, we need distribution different from point-to-point. Such distribution must provide interactions between any two points in the network and possibly more, as with a conference telephone call; simultaneous interactions, such as the telephone system provides, between many pairs of locations; and central switching, so as to interconnect pairs with minimum delay. *

Information about the utility of multiple locations should come from experience with Picturephones(R) in the three Chicago projects. ** In its current state, the Picturephone is not acceptable for a majority of telemedicine applications because of its relatively poor visual resolution, small screen size, rigidity as to field of view, and mounting. It is, however, a means of visual and auditory transmission that interconnects number of pairs at different locations simultaneously. Switching is accomplished by users in a manner similar to the telephone. ***

Edward Dickson and Raymond Bowers explain that what the video telephone does is to allow "patterns of medical information exchange to evolve in response to the needs and preferences of users rather than under the constraint of the limited interconnection possibilities built into the CCTV system. ****

The video telephone is capable of being widely interconnected in a switched network because it uses ordinary telephone wires, thus its video signal bandwidth is restricted to 1 MHz. Since television requires 6 MHz of bandwidth it can only be transmitted by wires with the characteristics of the coaxial cable, which are far more expensive than telephone wires. Currently, there are cables which can carry 40 channels, and theoretically may carry many more. When a cable system interconnects a large number of user locations, it becomes apparent that the conditions for a switched television network may be in the offing. * Some cable systems already have two-way capability, either through bi-directional amplification in single strands or through two or more cables. Dedicated two-way cables (cables assigned to institutions for their use) have been built for telemedicine projects.** The cable used by Lakeview Clinics incorporates terminals in hospital rooms, plus several available terminals in the Clinics' examining rooms and offices. Mount Sinai-Wagner's link provides one terminal location at the hospital, but has eight terminals available at the Wagner clinic. In both systems, flexibility is facilitated by mobile camera-microphone carts which may be "plugged in" at any of the terminal locations.

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* It may be argued that switching should be user-activated, such as is the case with the telephone. However, the telemedicine facility in the patient's home, in the clinic, the CCU, or physician's office, is not there for just anyone to "call." It may be more rational to devise a set of computer-controlled protocols by which the computer is informed as to who is eligible to call whom, and makes mandated interconnections as rapidly as bandwidth becomes available. Questions of identification of callers and priority of calls need to be addressed.

** See Chapter IV, #'s 1, 5, and 6.

*** A brief review of the Picturephone's technical specifications related to medical applications is provided by Christopher Stockbridge, of Bell Laboratories. He points out that the instrument was designed for visual telephony but that some medical functions can be achieved, especially if certain adaptations are made.[9]

**** By "CCTV," Dickson and Bowers mean a two-way closed-circuit television system. Their book, although characterized as "a preliminary technology assessment" is the most thorough review of the video telephone's capacities and potentials that we have seen.[10]

The concept of dedicated cables to interconnect hospitals, clinics, and neighborhood health centers is advocated by some,*** because there is unrestricted use of the full bandwidth of the cable(s) and security of communication. Other planners favor use of local CATV systems, since these systems can provide many additional interconnections not necessarily limited to medical facilities. Furthermore, rather than making substantial outlays to build a dedicated cable, the health system could lease dedicated channels in a cable system built by others. **** Whether the practical benefits in leasing channels override those of security and availability when the entire cable is dedicated will probably be determined in response to local considerations of access requirements and costs. Cable television may not provide the only models for widespread interactive broadband television use, but at the moment it seems to hold the most promise of any of the available technologies.

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* Particularly if one recalls that in 1948, when the first CATV systems started, cables carried only five channels. Technological advances in telecommunication tend to come quite rapidly once they begin.

** Lakeview Clinics and Mount Sinai Hospital-Wagner Houses both use cables which were built by commercial operators and are owned by the operators.

*** Plans for both the Kansas City "Network for Health"[11] and the cable project based on the Colorado Medical Center in Denver [12] have indicated preference for dedicated cables. Neither plan has yet been implemented.

**** Unfortunately, this solution is not as simple as it sounds. Public service communication demands on the newer two-way cable systems include those related to government, education, social services, public access, libraries, consumer information, and an ill-defined but potentially-important area referred to as "citizen participation" which can mean everything from widely-dispersed town meetings to polling. Other non-entertainment services would include business communication, "shopping-by-television," alarm systems, credit-card and signature verification, and, a bit further on, mail delivery. Further complicating the issue are many unresolved problems in cable technology, including but by no means limited to: reliable transmission of two-way signals; effective and efficient terminal hardware; integration of computers and software they require to manage the system's intricacies. For useful discussions of some of these issues see the studies done by Carl Pilnick[13] and the Panel on Telecommunications Research, Committee on Telecommunications, National Academy of

What should be done when a finite number of channels becomes clogged with transactions? One answer, which was suggested above, is that many functions do not require full television bandwidth. Other methods would allow some narrow-band transmission during broadband transmission without disturbing the latter. This is discussed in greater detail in Appendix B "Telemedicine Time-Sharing on Cable TV." Development of optical fiber technology for shielded transmission of coherent light would provide bandwidth for an enormous number of channels in a smaller "cable" than is required for the coaxial variety. Further, it would likely be much cheaper, once the questions have been resolved which make its use infeasible today.*

It may be hard to support arguments for further expansion when existing telemedicine facilities are underused. To what extent is underutilization a function of lack of exploitation, indifference, difficulty of operation and/or communication, as well as access factors of geography, time and services delivered?

Engineering[14], (pp. 48-68, in particular). Note also that, in some localities—Anaheim, California, for example—it is suggested that at least three cables (trunks) are required to serve anticipated needs.

* See the sections on optical communication, pp. 114-129 in the National Academy of Engineering's study.[14]

1. Bashshur, Rashid, Telemedicine: Explorations in the Use of Telecommunications in Health Care, in Bashshur, Rashid, Youssef, Zakhour I., and Armstrong, Patricia, eds., "Telemedicine," published by Charles Thomas, Springfield, Ill. (Publication 1974).
2. Shinn, Allen M., Jr., "Telemedicine: A Preliminary Assessment of the Research Needs," paper presented at the IEEE conference on Systems, Man, and Cybernetics, Boston, Mass., Nov. 5-7, 1973.
3. Reid, Alex, New Direction in Telecommunications Research, The Sloan Commission on Cable Communication, New York, 1971.
4. Andrus, W. Scott, and Bird, Kenneth T., Boston, "Teleradiology: Evolution Through Bias to Reality," Chest, Vol. 62, pp. 656-657, Dec., 1972.
5. Andrus, W. Scott, and Bird, Kenneth T., "Operational Telemedicine: Present Capabilities and Future Needs," Unpublished ms. 2/22/73.
6. (Relevant Reference) Bennett, Donald and Gardner, Reed, "Current Status of EEG Telephone Telemetry," Clinical Electroencephalography, (forthcoming, 1974).
7. Kalba, Konrad K., Communicable Medicine, Cable Television and Health Services, a report prepared for the Sloan Commission on Cable Communications, Sept., 1971, p. 7.
8. Shannon, Gary W., "Impact of Telemedicine on Accessibility," paper presented at a conference on telemedicine sponsored by the Medical Care Organization at the University of Michigan, Ann Arbor, Oct. 29 and 30, 1973, a revised and expanded version of which is included in Bashshur, et. al. eds., Telemedicine, published by Charles Thomas, Springfield, Ill. (Publication 1974).
9. Stockbridge, Christopher, "The Performance of Picturephone Systems in Transmitting Medical Data." Reprint from the Society of Photo-Optical Instrumentation Engineers Seminar-in-Depth on Application of Optical Instrumentation in Medicine, November 29-30, 1972, Chicago, Ill. 8 pp. mimeo.
10. Dickson, Edward M., in association with Bowers, Raymond, The Video Telephone, A New Era in Telecommunications, prepared for the National Science Foundation, Research Applied to National Needs, June, 1973.
11. "A Network for Health," plan prepared for the Missouri Regional Medical Program by the Atlantic Research Corporation, Alexandria, Va., Aug., 1972.
12. Report to the Congress by The Lister Hill Center for Biomedical Communications, April, 1972, DHEW Publication #(NIH) 72-268, p. 4.
13. Pilnick, Carl, Cable Television: Technical Considerations in Franchising Major Market Systems, Rand Corporation, Santa Monica, Calif., Apr., 1973.
14. Telecommunications Research in the United States and Selected Foreign Countries, A Preliminary Survey, Panel on Telecommunications Research, National Academy of Engineering, Washington, D.C., June, 1973.

APPENDIX A

TELEMEDICINE PROJECTS IN OPERATION

(as of January 31, 1974)

(transmission, equipment, services, configurations, schedules)

APPENDIX A

EXPLANATORY NOTES

FIELDS

General Medicine
Specialist Medicine
Adult, General
Adult, Specialist
Pediatric, General
Pediatric, Specialist
Internal Medicine
Ob-Gyn
Psychiatry & Mental Health
Orthopedics
Radiology
Dermatology
Urology
Otolaryngology
Emergency
Intensive/Cardiac Care
Anesthesiology
Pharmacy
Speech Therapy
Social, Non-Medical
Administration
Education
Continuing Education
Medical Ed. (Undergrad)
Medical Conferences
Medical Grand Rounds
Medical Records

SERVICES

Consultation
Diagnosis, Therapy
Monitoring (of Professionals)
Monitoring (of Patients)
Supervision of Prof. Tasks
Conferences
Access to Records
In-Service Training
Teaching

INTERACTIVE MODES

MD-MD
MD-Patient
MD-Medical Students
MD-RN
MD-NP or NC
MD-Medic or Physician's Aide
Reg. Pharm.-Pharm. Asst.
Hosp. Pers.-Social Workers
Office-Office
Staff-Data Bank
Therapist-Patient (Aide present with patient)

*	Emphasized special program
P	Patient present
P?	Patient sometimes present

Explanatory Notes

1.	P-A	Ambulatory care
	P-B	In-patient care
	P-C	Chronic care, institutionalized

Size of current potential patient population noted as figure after code above (as P-A 1300, for Mt. Sinai-Wagner).

2.	A	Microwave transmission
	B	Cable television transmission (dedicated only, in current use)
	C	Laser transmission
	D	Infra-Red transmission
	E	Broad-band (full audiovisual capacity)
	F	Black and White
	G (a)	Color, NTSC National Television System Committee (American Standard)
	G (e)	Color, SECAM Sequentiel couleur a memoire (French Standard)
	H	SLOW-SCAN (Narrow-band pictures brought to acceptable resolution by using more time in transmission).
	I	Telemetry of ECG's, EEG's
	J	Electronic stethoscope
	K	Adaptors for interface with optical instruments (Microscope, otoscope, etc.).
	L	Additional camera for closeups, with patient (for distant consultant to see).
	M	Additional camera for wide shot of distant room, with consultant (for patient to see).
	N	Remote control of patient's camera by physician
	O	Remote control of physician's camera by patient (or by professional in attendance).
	P	Picturephone, Black and White, switched Net

3. S-A Users, such as physicians and nurses, can turn the system on as needed. They can call and make contact with other locations in their system, in effect doing the switching. They handle camera focus and field of view, audio volume controls, etc. Technicians needed only for repair and maintenance of equipment. (Chicago Picturephone installations, Lakeview Clinics, Blue Hill-Deer Isle, Mt. Sinai, Case-Western Reserve, Cambridge Hospital, Rural Health Associates, Nebraska Slow Scan).

S-B The link or system must be activated by a technician, which means ordinarily that the system is "turned on" for stated, regular (scheduled) periods. The links, if there are more than one in the system, must be switched from a central point—usually by a technician—but as long as the system is "on," interactors may manipulate camera controls, sound levels, etc.

(Massachusetts General)

S-C The system is run almost completely by technicians, who activate it, switch interacting locations, operate cameras and sound. System hours are rigidly scheduled.

("Interact" Network, Nebraska V.A. Hospitals)

APPENDIX A

1. TITLE OF PROJECT: Bethany/Garfield Community Health Care Network

NAMES OF INSTITUTIONS AND TOWNS:

Bethany Brethren Hospital
3420 West Van Buren Street
Chicago, Illinois 60624

Garfield Park Hospital
May-Rosen Clinic

Bethany Clinic
Bethany Drug Center

PRINCIPAL PEOPLE, AND TITLES:

Vernon Showalter, Administrator, Bethany/Garfield Hospital Complex
Project Director
Gerald Johnson, Coordinator
Sylvia George, System Evaluator
James Muldoon, Supervisor of Evaluation

PROJECT BEGAN OPERATIONS: July 1, 1972

GRANT AND PERIOD: 6/29/72 - 11/28/73 (HEW-HCTD)

1st 12 Months: $121,435 Includes equipment
Final 5 Months: 66,451 and installation costs

PATIENT POPULATION SERVED, AND SIZE: [1]

P-A, P-B 109,000

DESCRIPTION OF SYSTEM TRANSMISSION MODES: P (Principal) B, E, F Secondary [2]

Number of Professional system users 100+

SYSTEM OPERATION, TYPE: S A [3]

FIELD	SERVICE	INTERACTIVE MODE
General Med.	Consultation	MD - RN
Specialist Med.	Consultation	MD - MD MD - RN
Emergency	Consultation	MD - MD
Pharmacy	Supervision	Reg. Pharm. - Pharm. Ass't.
Social Work	Conference	Hospital Personnel - Social Workers
Administration	Conference	Office - Office
Continuing Ed.	Conference	MD - RN
Medical Conferences	Conference	MD - MD
Medical Records	Access	(Note: See problems under "Implementation-Wide Band Equipment.")

Hours system is in use, per month: 42 (Avg., May, June, July, 1973)
No. of Transactions, per month: 812.76 (Avg., May, June, July, 1973)

TYPICAL SCHEDULE: Non-scheduled, 24-hour availability.

DIAGRAM OF SYSTEM

(ENTIRE AREA IS ONE MILE SQUARE)

ORIGINAL LOCATIONS OF PICTUREPHONES

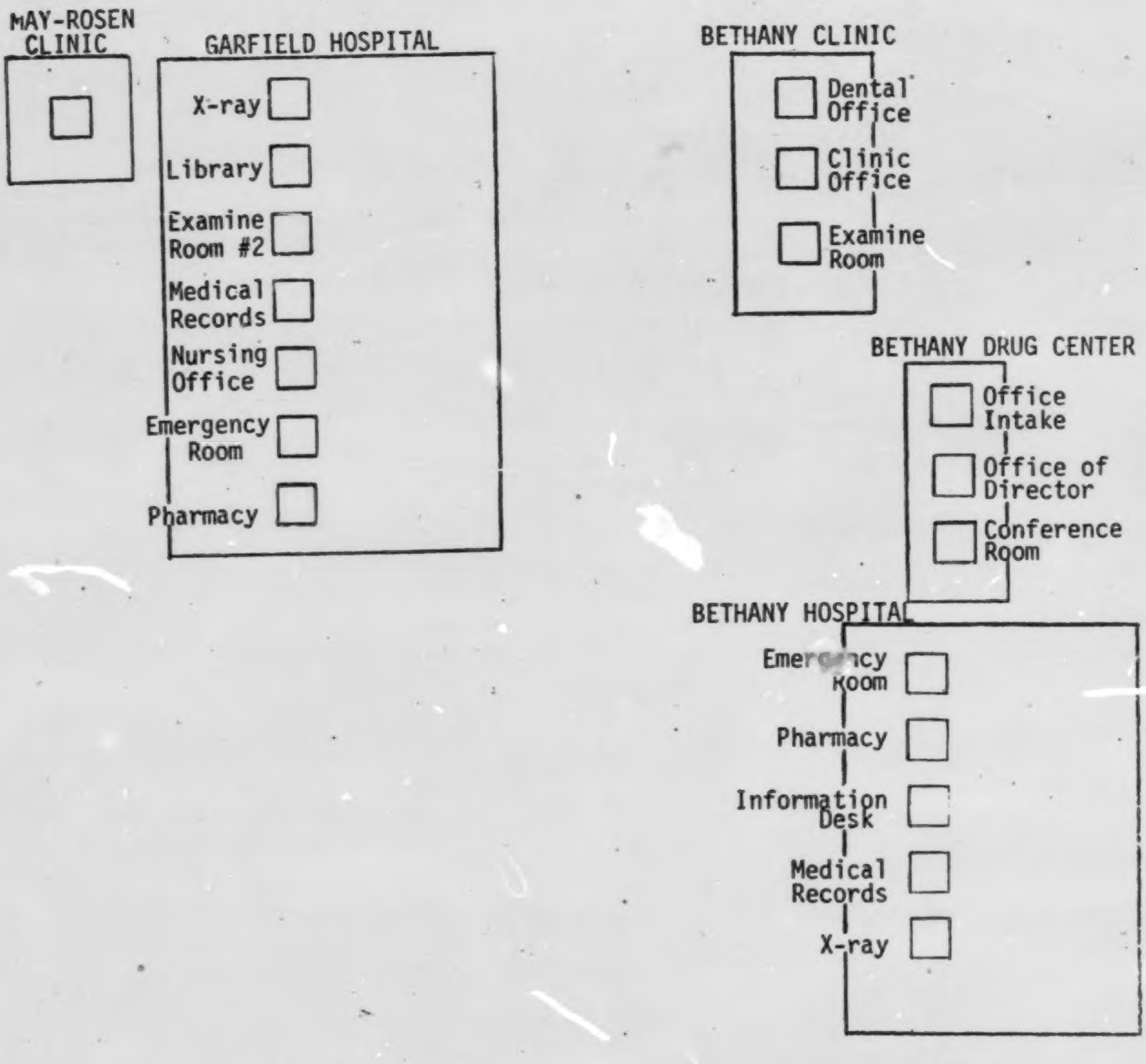

MAY-ROSEN CLINIC
GARFIELD HOSPITAL
X-ray
Library
Examine Room #2
Medical Records
Nursing Office
Emergency Room
Pharmacy
BETHANY CLINIC
Dental Office
Clinic Office
Examine Room
BETHANY DRUG CENTER
Office Intake
Office of Director
Conference Room
BETHANY HOSPITAL
Emergency Room
Pharmacy
Information Desk
Medical Records
X-ray

DIAGRAM OF SYSTEM

RE-CONFIGURATION - COMPLETED MAY 1, 1973

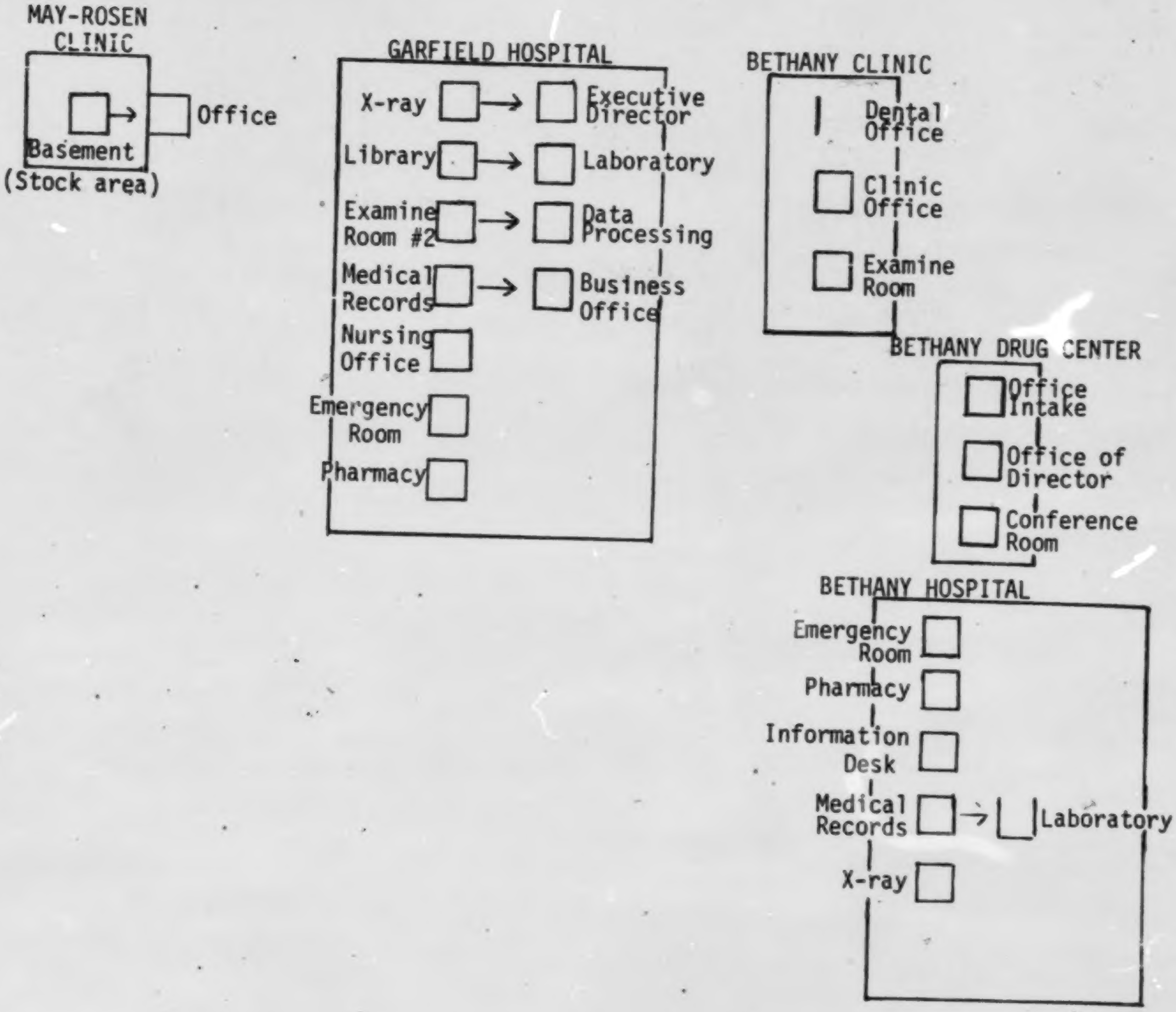
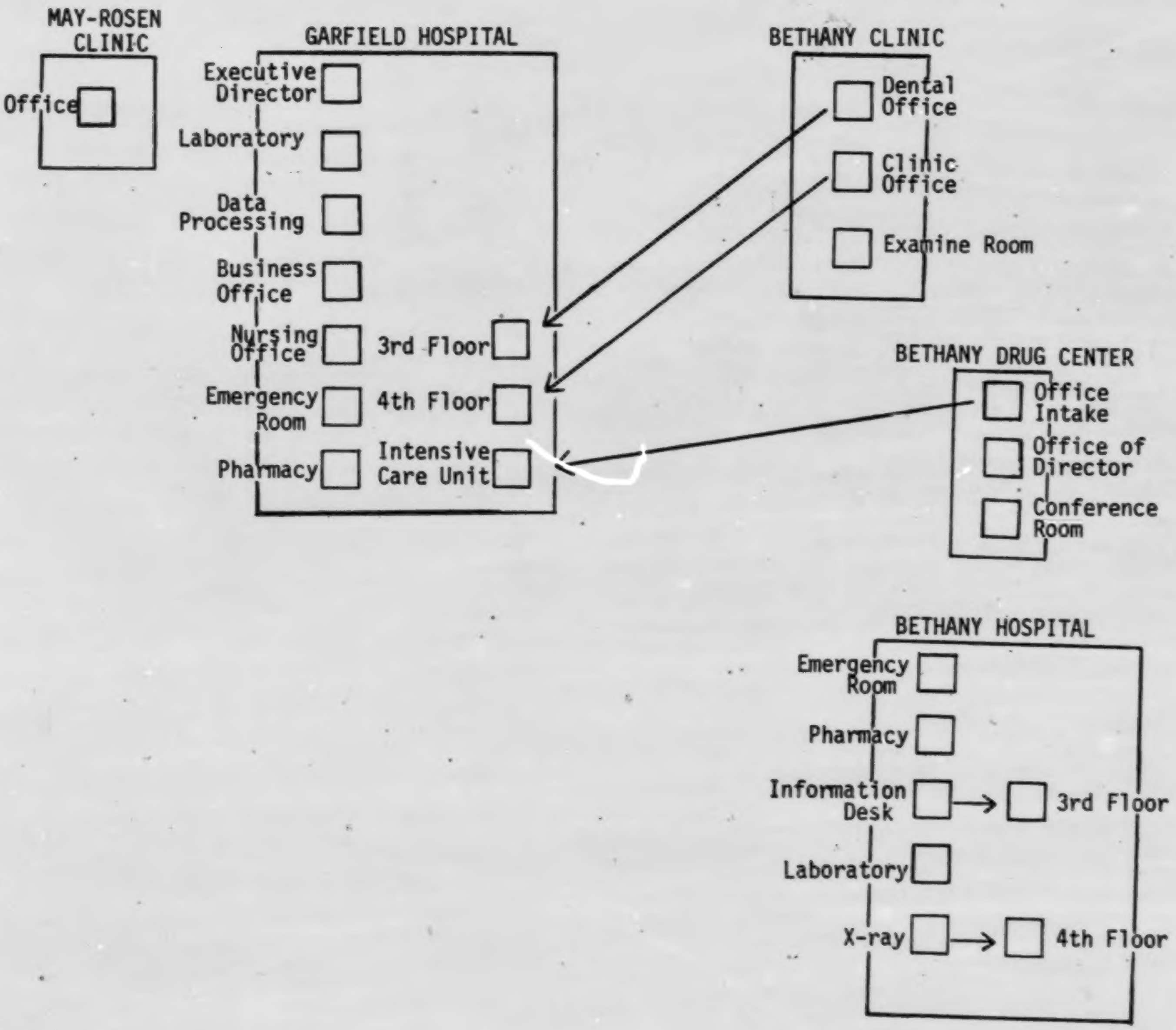

MAY-ROSEN CLINIC
Office
Basement (Stock area)
GARFIELD HOSPITAL
X-ray
Executive Director
Library
Laboratory
Examine Room #2
Data Processing
Medical Records
Business Office
Nursing Office
Emergency Room
Pharmacy
BETHANY CLINIC
Dental Office
Clinic Office
Examine Room
BETHANY DRUG CENTER
Office Intake
Office of Director
Conference Room
BETHANY HOSPITAL
Emergency Room
Pharmacy
Information Desk
Medical Records
Laboratory
X-ray

DIAGRAM OF SYSTEM

COMPLETED OCTOBER 16, 1973


MAY-ROSEN CLINIC
Office
GARFIELD HOSPITAL
Executive Director
Laboratory
Data Processing
Business Office
Nursing Office
Emergency Room
Pharmacy
3rd Floor
4th Floor
Intensive Care Unit
BETHANY CLINIC
Dental Office
Clinic Office
Examine Room
BETHANY DRUG CENTER
Office Intake
Office of Director
Conference Room
BETHANY HOSPITAL
Emergency Room
Pharmacy
Information Desk
3rd Floor
Laboratory
X-ray
4th Floor

2. TITLE OF PROJECT: Blue Hill-Deer Isle Telemedicine Project

NAMES OF INSTITUTIONS AND TOWNS:

Blue Hill Memorial Hospital
Blue Hill, Maine

Island Medical Center
Stonington
Deer Isle, Maine

PRINCIPAL PEOPLE, AND TITLES:

Richard Britt, M. D., Administrator
Blue Hill Memorial Hospital, Project Director

Elaine McCarty, R. N., Nurse Practitioner
Island Medical Center, Stonington

Bradlee Brownlow, M. D., Deputy Director

PROJECT BEGAN OPERATIONS: April, 1973

INITIAL GRANT: $60,000 (Maine Regional Medical Program)

ESTIMATED ANNUAL OPERATING COST: $3,000 (Hardware maintenance)

PATIENT POPULATION SERVED, AND SIZE[1]
P-A Winter (potential) 2,500
Summer (potential) 5,000

DESCRIPTION OF SYSTEM TRANSMISSION MODES: A, E, F, L, N, O[2]

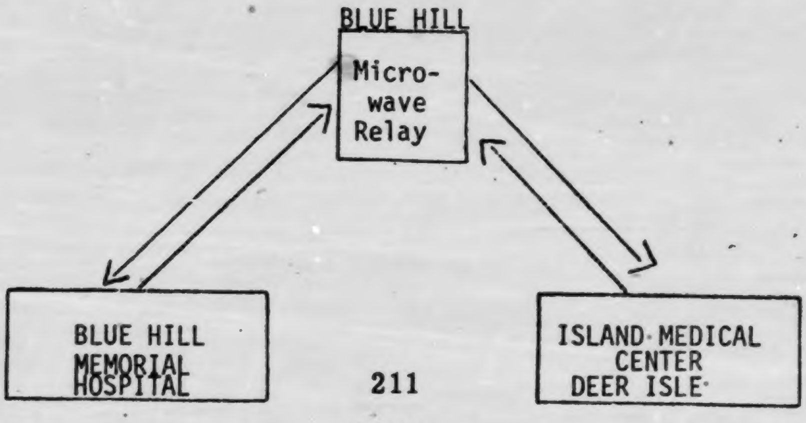
SYSTEM OPERATION, TYPE: S A[3]

FIELDS	SERVICES	INTERACTIVE MODES
General Medicine	Consultation	MD-NP P
Paraprofessional Education	Teaching	MD-Ambulance Attendants

HOURS SYSTEM IS IN USE, PER MONTH: 45-60
NUMBER OF TRANSACTIONS, PER MONTH: 70-90

TYPICAL SCHEDULE: Bulk of use is weekdays, during periods when Nurse Practitioner is in attendance, generally in the 8:00 A. M. - 6:00 P. M. period.

DIAGRAM OF SYSTEM:



3. TITLE OF PROJECT: Cambridge Telemedicine Project

NAMES OF INSTITUTIONS AND TOWNS:

Cambridge Hospital
1493 Cambridge Street
Cambridge, Massachusetts 02139

M.E. Fitzgerald School Adult Health Center
Donnelly Field Neighborhood Health Center
Neighborhood Family Care Center

PRINCIPAL PEOPLE AND TITLES:

Gordon T. Moore, M.D., Community Medicine Unit, Department of Medicine Cambridge Hospital, Co-Director

Albert R. Martin, M.D., Community Medicine Unit, Department of Medicine, Cambridge Hospital, Co-Director

Rosemary Bonanno, Community Medicine Unit, Department of Medicine, Cambridge Hospital, Research Associate

Thomas Willemain, Ph.D., M.I.T., Computer Simulation Modeling of Consultation System

PROJECT BEGAN OPERATIONS: December 8, 1972

GRANT AND PERIOD: 6/27/72-1/25/74 — $176,512 (HCTD)

PATIENT POPULATION SERVED, AND SIZE [1]

P-A: 29,200 in catchment area of three clinics. Clinic service is free to anyone; X-rays, lab work are charged to patient.

DESCRIPTION OF SYSTEM TRANSMISSION MODES: A, E, F [2]

SYSTEM OPERATION, TYPE: S A [3]

FIELD	SERVICE	INTERACTIVE MODE
Adult, Internal Medicine	Consultation	P MD-NP

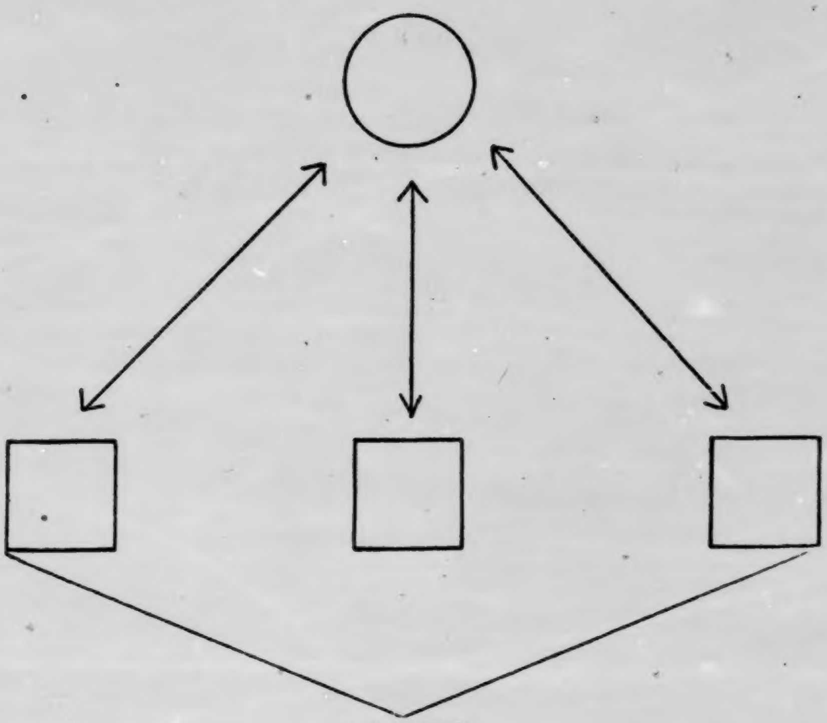
HOURS SYSTEM IS IN USE, PER MONTH: Potential 80; Actual 3.8 hours (avg.)

NUMBER OF TRANSACTIONS, PER MONTH: 23.4 (avg.)

TYPICAL SCHEDULE: Randomized. See text, Chapter Four, Utilization.

CAMBRIDGE HOSPITAL

(1 Telecenter)
1 Camera



3 CENTERS
Each with one tele-station,
1 camera each

4. TITLE OF PROJECT: Case-Western Reserve School of Medicine Anesthesiology Project (Supervision of Nurse-Anesthetist by Physician Anesthesiologist).

NAMES OF INSTITUTIONS AND TOWNS:

Case Western Reserve University School of Medicine
Department of Anesthesiology
Lakeside-University Hospital
Cleveland, Ohio

Veterans Administration Hospital
(Surgical Suite)
Cleveland, Ohio

PRINCIPAL PEOPLE, AND TITLES:

J.S. Gravenstein, M.D., Director and Professor of Anesthesia, School of Medicine, Principal Investigator

Yoh-Han Pao, Ph.D., Professor and Head of Division of Electrical Engineering and Applied Physics, School of Engineering, System Designer

Department of Operations Research (several personnel), Evaluation

PROJECT BEGAN OPERATIONS: January, 1973

GRANT AND PERIOD: 6/27/72-10/15/73 - $94,295. Provided by HCTD.

PATIENT POPULATION SERVED, AND SIZE: [1]

P-B Surgical patients at V.A. Hospital

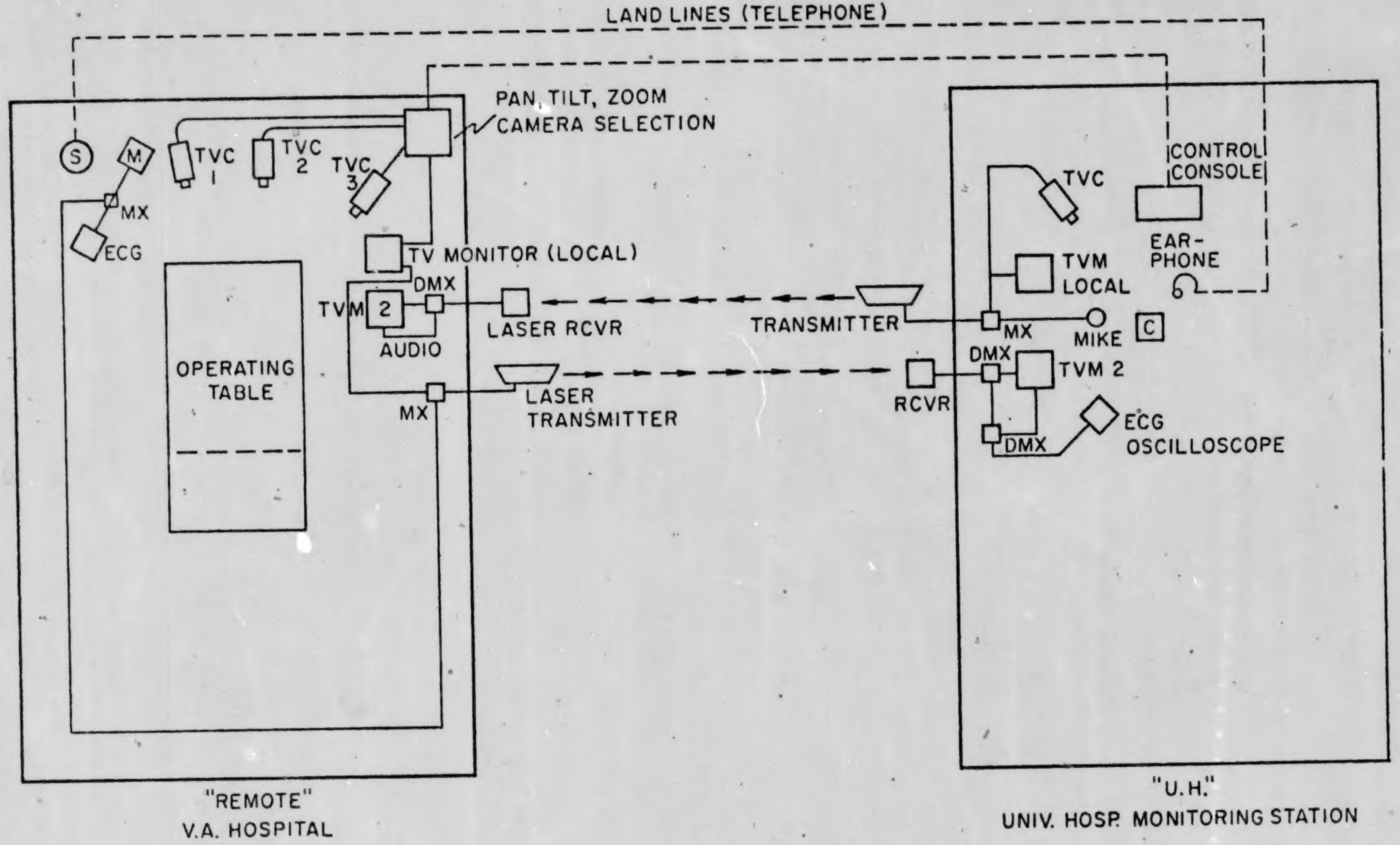
DESCRIPTION OF SYSTEM TRANSMISSION MODES: B, C, F, G(a), I, J, N [2]

SYSTEM OPERATION, TYPE: S A [3]

FIELD	SERVICE	TRANSMISSION MODE
*Anesthesiology	Supervision of Professional Tasks	MD-RN P (Anesthesiologist-to-Anesthetists)

HOURS SYSTEM IS IN USE, PER MONTH: Approximately 40

NUMBER OF TRANSACTIONS, PER MONTH: Approximately 20 (patients under anesthesia)


LAND LINES (TELEPHONE)
PAN, TILT, ZOOM
CAMERA SELECTION
S
M
MX
ECG
TVC 1
TVC 2
TVC 3
TV MONITOR (LOCAL)
DMX
TVM 2
AUDIO
MX
OPERATING TABLE
LASER RCVR
LASER TRANSMITTER
TRANSMITTER
RCVR
CONTROL CONSOLE
TVC
EAR-PHONE
TVM LOCAL
MX
MIKE
C
DMX
TVM 2
DMX
ECG OSCILLOSCOPE
"REMOTE"
V.A. HOSPITAL
"U.H."
UNIV. HOSP. MONITORING STATION

Schematic of University Hospital - Veterans Administration Hospital 2-way Link.

5. TITLE OF PROJECT: Cook County Hospital, Department of Urology Picturephone Network

NAMES OF INSTITUTIONS AND TOWNS:

Department of Urology
Cook County Hospital
Chicago, Illinois

PRINCIPAL PEOPLE AND TITLES:

Irving M. Bush, M.D.
Chairman, Department of Urology

PROJECT BEGAN OPERATIONS: February, 1972

ANNUAL OPERATING BUDGET: $7,000

PATIENT POPULATION SERVED, AND SIZE:[1] P-A 170 per day;
P-B 250 at any time

DESCRIPTION OF SYSTEM TRANSMISSION MODES: P, N (control of O.R. camera),[2]
K (fiberoptic endoscope)

SYSTEM OPERATION, TYPE: S A[3]

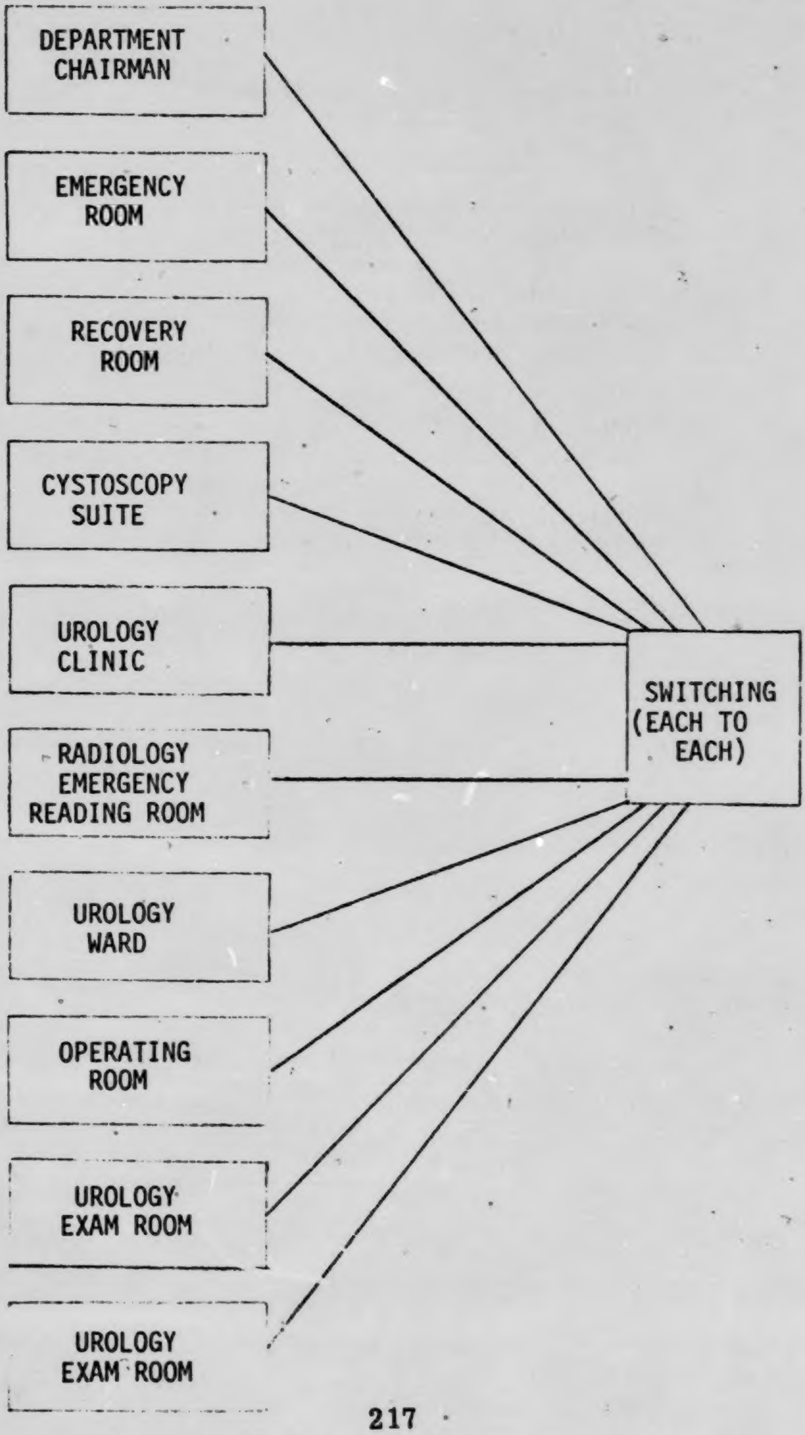
FIELDS	SERVICES	TRANSMISSION MODES
Urology	Administration	
	Consultation	P MD-MD; MD-RN
	Monitoring	RN - P
	Conferences	MD - P
Sex Dysfunction Clinics	Diagnoses and Counselling	MD - P

HOURS SYSTEM IS IN USE, PER MONTH: 40 aggregate

NUMBER OF TRANSACTIONS, PER MONTH: 950, average

TYPICAL SCHEDULE: None. System is on for use at all times, 720 hours per month. Hours of greatest use tend to coincide with hours of normal activity. Thus, more use 9 a.m. - 5 p.m.

DIAGRAM OF SYSTEM


DEPARTMENT CHAIRMAN
EMERGENCY ROOM
RECOVERY ROOM
CYSTOSCOPY SUITE
UROLOGY CLINIC
RADIOLOGY EMERGENCY READING ROOM
UROLOGY WARD
OPERATING ROOM
UROLOGY EXAM ROOM
UROLOGY EXAM ROOM
SWITCHING (EACH TO EACH)

6. TITLE OF PROJECT: Illinois Department of Mental Health Medical Center Complex/Community Mental Health Program Picturephone Network

NAMES OF INSTITUTIONS:

Illinois Department of Mental Health
Medical Center Complex
Chicago, Illinois 60612

Illinois State Psychiatric Institute
Illinois State Pediatric Institute
(phasing out of project)
Institute of Juvenile Research
The Pilsen Mental Health Center
West Side Organization Mental Health Center

PRINCIPAL PEOPLE, AND TITLES:

Lester H. Rudy, M. D., Project Director
Michael Flynn, Project Manager
Jerry Kroe, Research Assistant

PROJECT BEGAN OPERATIONS: September 30, 1973

GRANT AND PERIOD:

6/30/72 - 6/29/73	$30,751	(HEW-HCTD)
6/30/73 - 7/15/74	41,785	(HEW-HCTD)

PATIENT POPULATION SERVED, AND SIZE [1]

P-A 135,000

DESCRIPTION OF SYSTEM
TRANSMISSION MODES: P [2]

Number of potential professional system users - 150, approx.

SYSTEM OPERATION, TYPE: S A [3]

SYSTEM OPERATION, TYPE: S A ^{3}

FIELD	SERVICES	TRANSMISSION MODES
Psychiatry & Mental Health	Consultation & Conference	Staff-Staff
Education	Conference	Staff-Staff
Administration	Access	Staff-Staff
Research	Conference	Staff-Staff
Social Services	Access	Staff-Staff

HOURS SYSTEM IS IN USE, PER MONTH: Not calculated

NUMBER OF TRANSACTIONS, PER MONTH: Not calculated

TYPICAL SCHEDULE: Non-scheduled, 24-hour availability

CONFIGURATION OF SYSTEM

12 Picturephones:

6 at Illinois State Psychiatric Institute
1 at Institute for Juvenile Research
1 at Healy School (special school for mentally retarded administered and supervised by Institute for Juvenile Research)
1 at West Side Organization Mental Health Center
1 at Pilsen Mental Health Center
2 at Illinois State Pediatric Institute (to be moved to other locations)

7. TITLE OF PROJECT: Lakeview Clinic Bi-Directional Cable Television System

NAMES OF INSTITUTIONS AND TOWNS:

Lakeview Clinic
Waconia, Minnesota

Lakeview Clinic
Jonathan, Minnesota

Ridgeview Hospital (110 beds)
Waconia, Minnesota

PRINCIPAL PEOPLE, AND TITLES

Jon Wempner, M.D., Project Director
(Member-Lakeview Clinic Group)

Edward D. McCormick, System Designer
(President, Community Information Systems, Inc.)

Juli Kane, Evaluator & Coordinator
(Community Information System, Inc.)

(NOTE: Lakeview Clinic is a group of six family practitioners, an obstetrician-gynecologist, a general surgeon, and an internist. Most FP's rotate to staff the Jonathan Clinic, on any day.)

PROJECT BEGAN OPERATIONS: January 1, 1973

GRANT AND PERIOD: 6/29/72 - 12/28/73

$195,168 provided by HCTD: $12,000 provided by Northlands Regional Medical Program for evaluation.

PATIENT POPULATION AND SIZE [1]

P-A, P-B
Lakeview Clinic has approximately 8,000 families in its practice from 8 towns in rural area immediately west of metropolitan Minneapolis.

DESCRIPTION OF SYSTEM
TRANSMISSION MODES: B, E, F, J [2]

SYSTEM OPERATION, TYPE: S A [3]

FIELDS	SERVICES	TRANSMISSION MODES
General Medicine	Consultation	MD-MD : MD-RN
Specialist Medicine	Consultation	P Md-MD
Ob-Gyn	Monitoring	MD- P
ICU-CCU	Monitoring	MD- P
Other in-patients	Monitoring	MD- P
Nurse-Education	In-Service Training	RN-RN

HOURS SYSTEM IN USE, PER MONTH: (See below)

NUMBER OF TRANSACTIONS, PER MONTH: 30 average

TYPICAL SCHEDULE:

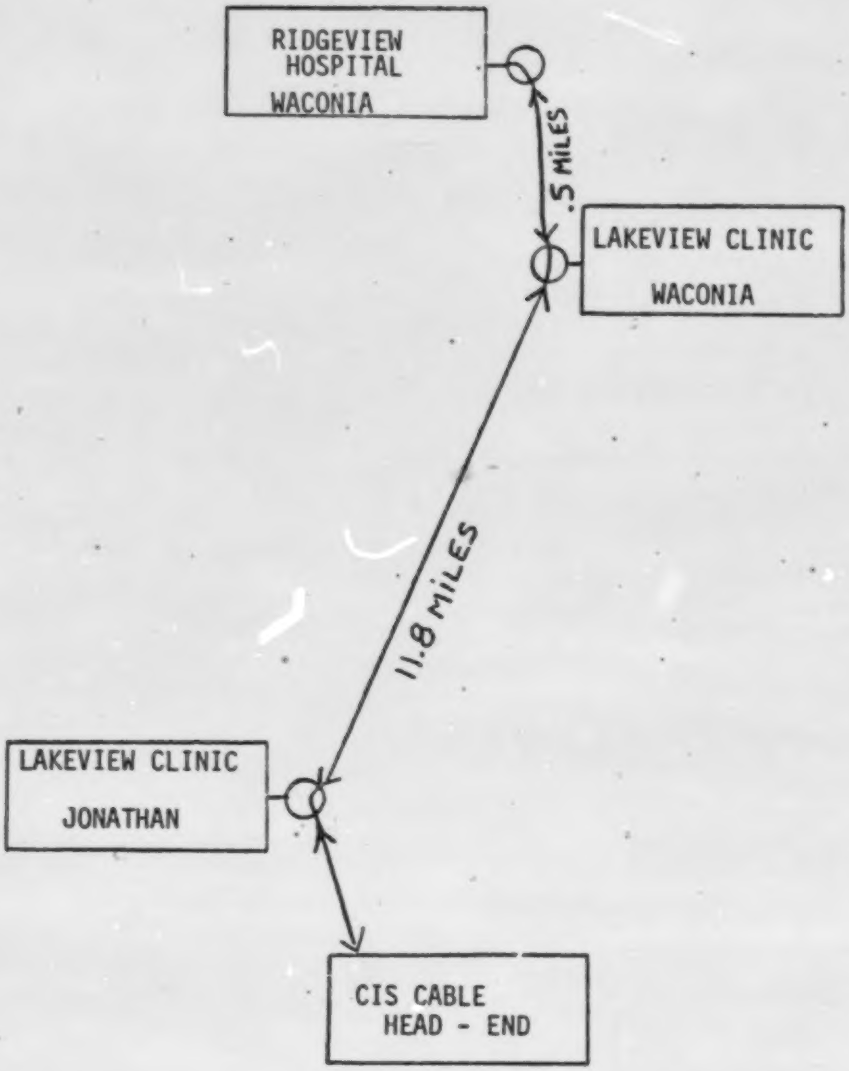
System is available at all times. There is no regular schedule, but most use is from 10 A.M. to 6 P.M. weekdays, 10 A.M. to 1 P.M. Saturdays.

Consultation between physicians average 2 to 3 minutes.

Patient monitoring may extend from 1 to 6 hours, with physician making checks of varying lengths during a monitoring period (MD at Clinic, patient in Hospital).

Physician at Jonathan occasionally uses system for rounds, when he has few patients in Hospital.

DIAGRAM OF SYSTEM:


RIDGEVIEW HOSPITAL WACONIA
.5 MILES
LAKEVIEW CLINIC WACONIA
11.8 MILES
LAKEVIEW CLINIC JONATHAN
CIS CABLE HEAD - END

NOTE: Each location can interact with either or both of the other locations. Switching is done at each location, independent of others.

8. TITLE OF PROJECT: Massachusetts General Hospital/Bedford V.A. Hospital/Logan Airport

NAMES OF INSTITUTIONS AND TOWNS:

Massachusetts General Hospital
Fruit Street
Boston, Massachusetts

Veterans Administration Hospital
Bedford, Massachusetts

Logan International Airport
Medical Station
Boston, Massachusetts

PRINCIPAL PEOPLE AND TITLES:

Kenneth T. Bird, M.D., Massachusetts General Hospital, Director
Mrs. Elizabeth Quinn, R.N., Acting Director of Teleconsultations Bedford Veterans Administration Hospital
Mrs. Gertrude Nolin, Administrative Assistant
Stanley Krainin, P.E., Systems Engineer of Project (CBS Laboratories)

PROJECT BEGAN OPERATIONS: Logan Airport Link: April, 1968
Bedford V.A. Hospital: March, 1970

ANNUAL OPERATING BUDGET: Logan, Current Annual: $332,224

GRANTS AND PERIODS: Logan:	3/1/67-2/29/68	$157,822	(HEW)
	3/1/68-2/28/70	$160,292	(HEW)
Bedford:	FY 1969	$ 91,500	(Veterans Administration)
	FY 1970	137,600	(Veterans Administration)
	FY 1971	103,200	(Veterans Administration)
	FY 1972	51,300	(Veterans Administration)
	FY 1973	186,399	(Veterans Administration)

NOTE: In Fiscal Year 1973, $127,408 was expended by V.A. at Bedford for the project.

PATIENT POPULATION SERVED, AND SIZE: [1]

Bedford V.A. Hospital:	P-A	(Veterans and families, chiefly psychiatric)
Bedford V.A. Hospital:	P-C	(Approximately 950 psychiatric)

(cont'd.)

PATIENT POPULATION SERVED, AND SIZE:[1] (cont'd.)

Logan Airport Link: P-A (12,000 airport employees, 50,000 airline travelers daily. Approximately 3,000 local residents.)

DESCRIPTION OF SYSTEM
TRANSMISSION MODES: A, B, E, F, I, J, K, L, M, N, O[2]

SYSTEM OPERATION, TYPE: S B[3]

FIELD	SERVICE	INTERACTIVE MODES	
Specialist Med.	Consultation/Dx	P	MD-NC, MD-MD
* Psychiatry, M.H.	Therapy	P	MD-Pt. (indiv. & group)
* Psychiatry, M.H.	Teaching	P	MD-Med. Students (BVAH-MGH)
Radiology	Consultation		MD-MD
* Dermatology	Consult/Therapy	P	MD-NC (chiefly BVAH)
* Otolaryngology	Diagnosis (Hearing Tests)	P	MD-Pt. (chiefly Logan)
Emergency	Consultation	P	MD-NC (chiefly Logan)
* Speech Therapy	Therapy	P	Therapist-Pt. (Aide with Pt.)
Social-Non-Medical	Conference		Hospital Personnel-Social Workers
Administration	Conference		Office-Office
* Education	Conference/ in service		Health Workers-Teachers, Parents (Logan)
* Education	Teaching		Health Workers-Comm. College (BVAH)
Cont. Education	Teaching		Videotape (non-interactive)
Medical Conferences	Conference		MD-MD, NC-NC
Med. Grand Rounds	Conference		MD-MD
Psych. Grand Rounds	Conference		
Pathology	Conference (CPC)		MD-MD (and others)
Drug Abuse	Therapy		MD-Pt. (individual and group)
Alcoholism	Therapy		MD-Pt. (individual and group)
Neurology	Consultation		MD-MD
Nursing	Conference		Various - NC

TYPICAL SCHEDULE (Bedford Link)

APPENDIX A

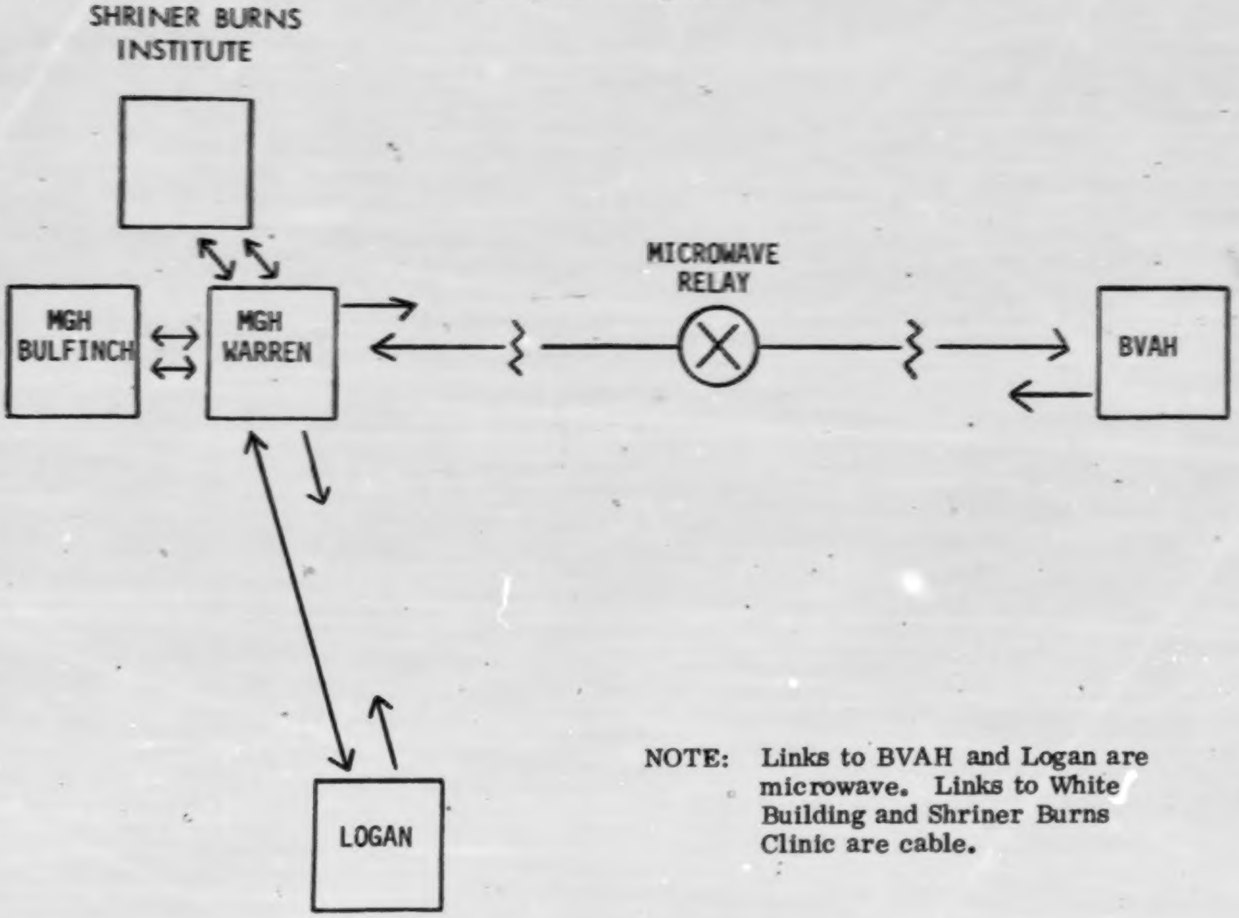
Mass. General

TELECONSULTATION

Programming schedule for the week of: Mar. 19, 1973

	Monday, 19	Tuesday, 20	Wednesday, 21	Thursday, 22	Friday, 23
8 – 9 a.m.				8:30 – 9:30 Couples Therapy	8:30 – 10:00 V.A.R.O & BVAH
9 – 10 a.m.	9:30 – 11:00 Psychodrama Group Therapy	Wd 62D Staff Conference Dr. G. Lazar	9:30 – 10:00 MGH Dietary & BVAH Dietary	E. Daniels Dr. Meskil 9:30 – 10:00 Chaplain VAH Pt. Interview (Taped)	Social Service Depts Conference
10 – 11 a.m.	Drug Pts. D. Slater	10:00 – 11:30 M.G.H. Psychiatric Grand Rounds	Speech Therapy J. Wheelden		
11 – 12 a.m.	Alchol Staff Conference Dr. A. Papas	From Ether Dome	Dermatology Clinic Dr. T. Fitzpatrick	M.G.H. Medical Grand Rounds from "Shriners"	
12 – 1 p.m.	Psychiatric Board Course Dr. N. Cassem	Drug Staff Conference	Neurological Board Course Dr. C. Plank	12:15 – 2:00 Vietnam Veterans	Psychiatric Board Course Dr. N. Moss
1 – 2 p.m.	Psychiatric Pt Interview (taped) H.M. Student	Dr. Lee Bolman	1:00 – 3:00 Normal Personality Interview	Era Group Therapy Dr. F. Carter	1:00 – 1:30 "Alcoholism" Pt. Education VTR – Dr. Papas
2 – 3 p.m.	Alcohol Hypnotherapy Dr. T. Hackett		Tape Dr. T. Dwyer M. Davy		
3 – 4 p.m.	Alcohol Pts Conference Dr. M. Murphy	Psychodrama Group Therapy Drug Pts	Psychodrama Group Therapy	3:30 – 4:30 Day Care Center Staff Conference	
		D. Slater	R. Ginn	Dr. M. Murphy	

Diagram of System


SHRINER BURNS INSTITUTE
MGH BULFINCH
MGH WARREN
MICROWAVE RELAY
BVAH
LOGAN

NOTE: Links to BVAH and Logan are microwave. Links to White Building and Shriner Burns Clinic are cable.

9. TITLE OF PROJECT: Mount Sinai-Wagner Bi-Directional Cable Link

NAMES OF INSTITUTIONS AND TOWNS:

Department of Community Medicine
Mount Sinai Medical Center
New York, New York

Wagner Child Health Station
Wagner Houses
New York, New York

PRINCIPAL PEOPLE, AND TITLES:

Edward Wallerstein, Coordinator, Section on Communication of Department of Community Medicine, Mount Sinai School of Medicine, Director

Rodney Alexander, Associate Director

Carter L. Marshall, M.D., Associate Professor of Community Medicine, Associate Dean, Mount Sinai School of Medicine, Principal Investigator

Nicholas Cunningham, M.D., Co-Director, Wagner Child Health Station

Beatrice E. Thomstad, R.N., M.P.H., Co-Director, Wagner Child Health Station

PROJECT BEGAN OPERATIONS: December 7, 1972

GRANT AND PERIOD: 6/27/72 - 6/26/75
$314,000; Funds provided by HCTD

PATIENT POPULATION SERVED, AND SIZE [1]

P-A (Pediatric) 1,300 children who live in Health District #17, New York City

DESCRIPTION OF SYSTEM
TRANSMISSION MODES: B, E, F, J, N [2]

SYSTEM OPERATION, TYPE: S A [3]

FIELDS	SERVICES	TRANSMISSION MODES
General Pediatrics	Consultation	P MD-RN
Pediatric Specialties Orthopedics, Nutrition, Psychiatry, Social Work	Consultation	P MD-RN
Administration	Conference	MD-RN; RN-RN; MD-Other; RN-Other; Other-Other

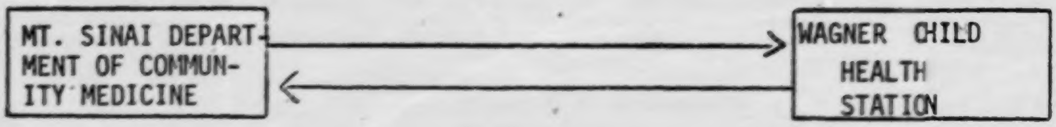
HOURS SYSTEM IS IN USE, PER MONTH:

System on 9 a.m. - 5 p.m., Monday - Friday. Therefore, system is on approximately 172 hours per month.

NUMBER OF TRANSACTIONS, PER MONTH: Varies, but trend is toward more use each month.

TYPICAL SCHEDULE: Wednesday afternoon regularly used for staff meetings; Last Friday afternoon of each month, regularly scheduled orthopedic clinic. Otherwise system is used on an "as-needed" basis.

DIAGRAM OF SYSTEM:


MT. SINAI DEPARTMENT OF COMMUNITY MEDICINE
WAGNER CHILD HEALTH STATION

NOTE: Camera cart can be connected at any one of eight separate locations for transmission at Wagner.

10. TITLE OF PROJECT: Nebraska Veterans Administration Network

NAMES OF INSTITUTIONS AND TOWNS:

Omaha Veterans Administration Hospital
Omaha, Nebraska

Criss Institute for Health
St. Joseph's Hospital
(Creighton University School of Medicine)
Omaha, Nebraska

University of Nebraska Medical Center
42nd and Dewey
Omaha, Nebraska

Nebraska Psychiatric Institute
University of Nebraska Medical Center
Omaha, Nebraska

Lincoln Veterans Administration Hospital
Lincoln, Nebraska
(Also serves University of Nebraska College of Dentistry, Lincoln)

Grand Island Veterans Administration Hospital
Grand Island, Nebraska

PRINCIPAL PEOPLE AND TITLES:

John Freil, Acting Chief, Medical Illustration Service
Omaha Veterans Administration Hospital

Reba Benschoter, Director Biomedical Communications
University of Nebraska Medical Center

David Gray, Coordinator, Lincoln V.A. Hospital

Charles De la Motte, Coordinator, Grand Island V.A. Hospital

Betty Warner)
Don Eggers) Coordinators, Nebraska Psychiatric Institute

Leon Benschoter, Director Biomedical Communications
Creighton University Health Sciences

PROJECT BEGAN OPERATIONS:	December, 1969
ANNUAL OPERATING BUDGET:	Approximately $100,000 (V.A. Hospitals only)
Funding Sources:	Veterans Administration University of Nebraska Medical Center Creighton University Health Sciences

NEBRASKA V.A. NETWORK

PATIENT POPULATION SERVED: [1]

P-A, P-B, P-C
Eligible veteran in-patients and out-patients,
chiefly from areas of Omaha, Lincoln, Grand Island

DESCRIPTION OF SYSTEM
TRANSMISSION MODES: A (Among V.A.H's) B (in Omaha and Lincoln
E, F, G(a), I, L (U. of Neb. only.) [2]

SYSTEM OPERATION, TYPE. S C [3]

FIELD	SERVICE	INTERACTIVE MODES
Medicine	Supervision,Consultation	MD-Med. Students; MD-MD
Psychiatry	Supervision,Consultation	P MD-Residents; MD-MD
Urology	Consultation	MD-MD
Hematology	Consultation	MD-MD
Medical Education	Lecture,Conference	MD-Med. Students
Psychology Education	Supervision,Consultation	MD-Pre-doctoral interns
Phys. Terapy Cont. Ed.	Lecture,Conference	PT-PT
Medical Conferences	Conference	MD-MD; MD-Med. Students
Psychotherapy	Therapy	MD - P (MD-MD)
Group Therapy	Therapy	MD - Ps
Voc. Rehabilitation	Conference	Counselor - P
Neurology	Lecture-Class	MD-Medical Students
Cont. Education	In-Service Training Conference	MD-Social workers RN-RN
Cont. Education	Conference	MD-MD
Administration	Conference	RNs
Administration	Conference	TV coordinators
Clerical Training	Conference	Teacher-Students

HOURS SYSTEM IS IN USE, PER MONTH: Avg. 140

NUMBER OF PARTICIPANTS, PER MONTH: Avg. 3,750

TYPICAL SCHEDULE: See following.

APPENDIX A

MAY, 1973 RM. N-313 3rd Floor Main CCTV SCHEDULE Nebraska V.A. Network

		8 - 9	9 - 10	10 - 11	11 - 12	12 - 1	1 - 2	2 - 3	3 - 4	4 - 5	7 - 10
Tuesday	5/1	Med Stu. Lect.		Hd.Nurse Trn. Prog	NPI & GI Only	DEMGO. Conf.	Internal Med. Rev.	Gen. Surg. Conf.	Hematology Conf.		
Wednesday	5/2	Med. Stu. Lect.		Nursing Conf.	NPI & GI Only	CHIP Conf.	Internal Med. Rev.		Pulmonary Conf.	Int. Med. Grad. Crse.	
Thursday	5/3	Med. Stu. Lect.	Neuro-Pathology			Patient Care Conf.	Internal Med. Rev.		Urology Conf.	Surgical Path Conf.	
Friday	5/4	Med. Stu. Lect.	Voc. Rehab. 9:00 - 10:30			NCME #178	NPI & GI Only	Tumor Board			
Monday	5/7	Med. Stu. Lect.	NCME #179			EKG Conf.	Internal Med. Rev.				
Tuesday	5/8	Med. Stu. Lect.		Hd.Nurses Trn.Prog.		DEMGO Conf.	Internal Med. Rev.	General Surg.Conf.	Hematology Conf.		
Wednesday	5/9	Med. Stu. Lect.	Med. Admin. Conf.			CHIP Conf.	Internal Med. Rev.		Patient Care	Int. Med. Grad Crse.	
Thursday	5/10	Med. Stu. Lect.	Neuro-Pathology		PMRS Conf.	Patient Care Conf.	Internal Med. Rev.		Urology Conf.	Surgical Path Conf.	
Friday	5/11	Med. Stu. Lect.	Voc. Rehab. 9:00 - 10:30			NCME #179	NPI & GI Only	Tumor Board	State Occup. Therapy Mtg.		
Monday	5/14	Med. Stu. Lect.	NCME #179		NPI & GI Only	EKG.Conf.	Internal Med. Rev.	R=M=C			
Tuesday	5/15	Med. Stu. Lect.		Hd.Nurses Trn. Prog	NPI & OH Only	DEMGO Conf.	Internal Med. Rev.	Gen. Surg. Conf.	Hematology Conf.		
Wednesday	5/16	Med. Stu. Lect.				CHIP Conf.	Internal Med. Rev.		Pulmonary Conf.	Int. Med. Grad. Crse.	
+M=C 6:30 A.M. Thursday	5/17	Med. Stu. Lect.	Retirement Seminar 9:00 - 4:00 p.m.			Patient Care(11th Floor)	Internal Med.			Surgical Path Conf.	Kidney Foundation
Friday	5/18	Med. Stu. Lect.	Voc. Rehab. 9:00 - 10:30			NCME #179	NPI & GI Only	Tumor Board			
Monday	5/21	Med. Stu. Lect.	NCME #180			EKG Conf.	Internal Med. Rev.	CCTV Meeting			
Tuesday	5/22	Med. Stu. Lect.		Hd.Nurses Trn.Prog.		DEMGO Conf.	Internal Med. Rev.	Gen.Surg. Conf.	Hematology Conf.		
Wednesday	5/23	Med. Stu. Lect.				CHIP Conf.	Internal Med. Rev.		O.R.Nurse Meeting	Int. Med. Grad. Crse.	
Thursday	5/24	Med. Stu. Lect.	Neuro-Pathology			Patient Care	Internal Med. Rev.		Urology Conf.	Surgical Path Conf.	
Friday	5/25	Med. Stu. Lect.	Voc. Rehab. 9:00 - 10"30			NCME #180		Tumor Board			
Monday	5/28	Med. Stu. Lect.	NCME #180		NPI & GI Only	EKG Conf.	Internal Med. Rev.				
Tuesday	5/29	Med. Stu. Lect.		Hd.Nurses Trn.Prog.	NPI & GI Only	DEMGO Conf.	Internal Med. Rev.	Gen.Surg. Conf.	Hematology Conf.		
Wednesday	5/30	Med. Stu. Lect.			NPI & GI Only	CHIP Conf.	Internal Med. Rev.		Death Conf.	Int. Med. Grad. Crse.	

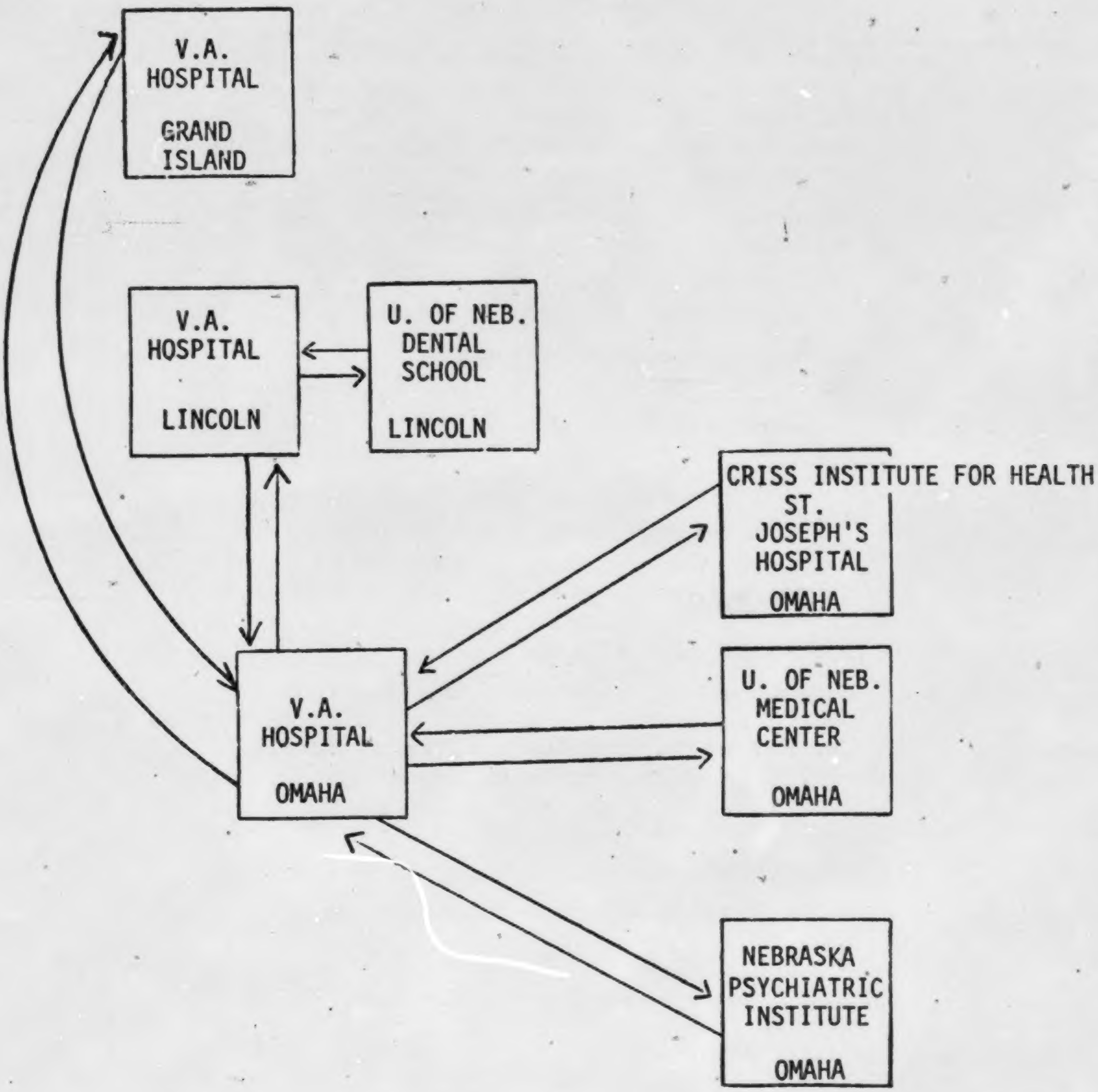
APPENDIX A
CCTV SCHEDULE

NEBRASKA V.A. NETWORK

MAY, 1973 RM. NE-1105 11th Floor (Separate capability, if needed. Programs can go out simultaneously)

		8 - 9	9 - 10	10 - 11	11 - 12	12 - 1	1 - 2	2 - 3	3 - 4	4 - 5	7 - 10
Tuesday	5/1			Research Seminar							
Wednesday	5/2		Dr. Aita's Class								
Thursday	5/3								NPI Grand Rounds 3:00 - 4:30 p.m.		
Friday	5/4			Alcoholic Grp. Therapy							
Monday	5/7										
Tuesday	5/8			Research Seminar							
Wednesday	5/9		Dr. Aita's Class								
Thursday	5/10								NPI Grand Rounds 3:00 - 4:30 p.m.		
Friday	5/11			Alcoholic Grp. Therapy							
Monday	5/14										
Tuesday	5/15			Research Seminar							
Wednesday	5/16		Dr. Aita's Class						R=M=C		
Thursday	5/17										
Friday	5/18			Alcoholic Group Therapy							
Monday	5/21										
Tuesday	5/22			Research Seminar							
Wednesday	5/23		Dr. Aita's Class								
Thursday	5/24								NPI Grand Rounds 3:00 - 4:30 p.m.		
Friday	5/25			Alcoholic Group Therapy							
Monday	5/28										
Tuesday	5/29			Research Seminar							
Wednesday	5/30		Dr. Aita's Class								

DIAGRAM OF SYSTEM


V.A. HOSPITAL
GRAND ISLAND
V.A. HOSPITAL
LINCOLN
U. OF NEB. DENTAL SCHOOL
LINCOLN
CRISS INSTITUTE FOR HEALTH
ST. JOSEPH'S HOSPITAL
OMAHA
V.A. HOSPITAL
OMAHA
U. OF NEB. MEDICAL CENTER
OMAHA
NEBRASKA PSYCHIATRIC INSTITUTE
OMAHA

Omaha - Lincoln	60 miles
Omaha - Grand Island	127 miles

Telco switch is in V.A. -- consequently V.A. can send simultaneously 2 different programs to Lincoln and Grand Island.

11. TITLE OF PROJECT: New Hampshire/Vermont Interactive Medical Television Network ("Interact")

NAMES OF INSTITUTIONS AND TOWNS:

Dartmouth Medical Center
Dartmouth Medical School, Dept. of Community Medicine
Hanover, New Hampshire 03755

University of Vermont Medical Center
Burlington, Vermont

Claremont General Hospital
Claremont, New Hampshire (85 beds)

Central Vermont Medical Center
Barre, Vermont (200 beds)

Rockingham Memorial Hospital
Bellows Falls, Vermont

Windsor State Prison
Windsor, Vermont

New Hampshire Vocational Technical College
Claremont, New Hampshire

PRINCIPAL PEOPLE AND TITLES:

Dean Seibert, M. D., (Dartmouth), Co-Director
George Welsh, M. D., (University of Vermont), Co-Director
Harold Pyke (Dartmouth), Operations Director
Charlotte Sanborn (Dartmouth), Director of Research

PROJECT BEGAN OPERATIONS: December, 1968

ANNUAL OPERATING BUDGET: $208,000 (Approx.)

Proposed Projected Funding Mix (1974-1977)

	1974 (%)	1977 (%)
Lister Hill Center for Biomedical Communications	52.2	10.9
Veterans Administration	21.4	10.9
United States Military Services	14.1	7.6
Network hospitals and medical centers	5.1	13.0
State Governments (Vt., N.H.)	1.7	18.5
Other Federal sources	1.6	6.5
Fees for service	3.9	8.1
All other	-0-	24.5

PATIENT POPULATION SERVED, AND SIZE [1]

P-A, P-B, P-C

DESCRIPTION OF SYSTEM
TRANSMISSION MODES: A, E, F, G(a) [2]

SYSTEM OPERATION, TYPE: S C [3]

* EMPHASIZED OR SPECIAL PROGRAM:

FIELD	SERVICE	INTERACTIVE MODE
Specialist Med.	Consultation	P MD-MD
* Psychiatry and Mental Health	Consultation In-Service Training	P MD-MD, MD-MH Worker MD-MH Worker
* Dermatology	Diagnosis, Supervision	P MD-Medic
* Speech Therapy	Therapy	P Therapist-Assistant
* Pharmacy	In-Service Training	RPH-Pharmacists, RN's
Continuing Education	In-Service Training	P? MD-[illegible], RN-RN
Medical Conferences	Conference	P? MD-MD, RN-RN
Medical Grand Rounds	Conference	P MD-MD

HOURS SYSTEM IS IN USE, PER MONTH:

Patients Seen/Month (Avg.) 177		
Dermatology	47	(8.6 hrs.)
Psychiatry	17	(8.6 hrs.)
Speech Therapy	30	(8.6 hrs.)
Tumor Clinic	13	(4.3 hrs.)
Other	70	(20.0 hrs.)

Teaching (including Grand Rounds, Case Consults, Conferences, etc.)

90 Transactions, occupying 100 hours (avg.)

TYPICAL SCHEDULE:

THE WEEK OF OCTOBER 1, 1973

MONDAY, OCTOBER 1

*	9:00-11:00 a.m.	SPEECH THERAPY - First speech therapy session of 1973-74: Mrs. Sue Ferland, Howard Mental Health Center, children from Claremont School District, parents, Guidance Counselors, aides and a learning disabilities instructor. UVM - CGH
**	12:00-1:00 p.m.	NCME TAPE SHOWING - A three part videotape produced by the Network of Continuing Medical Education: "Managing the Hyperactive Child; U.S. Acupuncture-

Status Report 1973; Antiobiotic Misadventure - The Case of Overkill." MHMH - CGH (Conf. Rm.) - CVMC (Board Room)

** 1:30-3:30 p.m. RENAL PHYSIOLOGY SEMINAR - Current Controversy in Renal Physiology - Dr. Valtin: "A New Theory For Countercurrent Multiplication in the Inner Medulla." MHMH (Radiation Therapy Conf. Rm.) - UVM (226 A Mary Fletcher Unit)

* 4:15-5:30 p.m. RADIOLOGICAL PHYSICS COURSE FOR HOUSE STAFFS - A joint course for house staffs of MHMH and UVM covering the physics of diagnostic radiology, basic radiation physics and radiation therapy safety. UVM - MHMH

TUESDAY, OCTOBER 2

** 12:30-1:30 p.m. PEDIATRIC JOURNAL CLUB-Dr. Robert Klein, MHMH, will lead a discussion on the following articles from the June 1973 Journal of Pediatrics: Hyperviscosity in the Neonate (Gross, Hathaway and McGaughey), Circulatory Effects of Hematocrit Variations (Fouron and Hebert) and Persistence of Fetal Circulation (Gersony). MHMH (F 6 A) - UVM (226 A Mary Fletcher Unit) - CGH Conference Room)

WEDNESDAY, OCTOBER 3

** 9:15-10:10 a.m. PEDIATRIC GRAND ROUNDS - FROM MHMH - Dr. John Caffey, Radiology Professor Emeritus, Columbia and Visiting Professor - Radiology and Pediatrics, University of Pittsburgh: "The Shaken Infant." MHMH (Bowler) - UVM (Austin) - CGH (Conference Room)

** 10:20-11:15 a.m. PEDIATRIC GRAND ROUNDS - FROM UVM - Dr. Helen Rodriguez, Pediatrics, Lincoln Hospital, N.Y.C.: "Problems of Health Care Delivery in the Ghetto." UVM (Austin) - MHMH (Bowler) - CGH (Conference Room)

** 12:15-1:15 p.m. NOON CONFERENCE - G.I. ROUNDS - "Interesting Cases." MHMH (Bowler) - CGH (Conference Room) - CVMC (Board Room)

** 4:00-5:15 p.m. RADIOLOGY CONFERENCE AND CONSULTATION - Dr. Morgan, Anesthesia, UVM: "Respiratory Stress of Adults." UVM (Austin) - CVMC (Board Room) - CGH (Conference Room)

THURSDAY, OCTOBER 4

** 7:30 - 8:30 a.m. SURGICAL GRAND ROUNDS - Dr. Topuzulu: "Portal Blood Flow and the Liver." UVM (Austin) - CVMC (Board Room)

9:00-10:00 a.m. SULLIVAN COUNTY MENTAL HEALTH CLINIC - Dr. Chapman of the Dartmouth - Hitchcock Mental Health Center provides psychiatric consults for SCMHC personnel. MHMH - CGH

THURSDAY, OCTOBER 4 (cont'd.)

*	10:00-11:00 a.m.	PSYCHIATRIC CONSULTATIONS - Psychiatrists from the Dartmouth-Hitchcock Mental Health Center provide psychiatric consultations for referrals from community physicians. MHMH - CGH
**	12:15 - 1:15 p.m.	NOON CONFERENCE - ENDOCRINE - Drs. Scharback, Sobel and Vanderlinde: "Hypothyroidism - A Spectrum of the Disease: Diagnostic Problems, Associated Complications and Management." MHMH (Bowler) - CGH (Conference Room)
**	1:30-3:30 p.m.	SURGICAL NURSING CONFERENCE - Nurses from MHMH and Alice Hospital: "Preoperative Preparation." MHMH (Bowler) - CGH (Conference Room) - UVM (Rowell Bldg. Auditorium) - CVMC (Board Room)
*	4:15-5:30 p.m.	RADIOLOGICAL PHYSICS COURSE FOR HOUSE STAFFS - A joint course for house staffs of UVM & MHMH covering the physics of radiation therapy and nuclear medicine and radiation safety. MHMH - UVM

FRIDAY, OCTOBER 5

**	8:00-9:00 a.m.	MEDICAL MORBIDITY-MORTALITY ROUNDS - Case Discussions: "Acute Leukemia vs. Megaloblastic Anemia." UVM (Austin) - CVMC (Board Room)
**	8:00-9:00 a.m.	BREAKFAST WITH DR. ALMY - Dr. Almy, MHMH, conducts an informal session on case discussions and problem solving for physicians, particularly family physicians. MHMH (Studio " ") - CGH (Conference Room)
**	1:00-2:30 p.m.	INHALATION THERAPY CONFERENCE - Dr. Dean, UVM: "Physiology Review As Related to Inhalation Therapy." UVM (226 A Mary Fletcher Unit) - CVMC (Board Room) - CGH (Conference Room) - MHMH (Studio "A")

SATURDAY, OCTOBER 6

**	8:00-9:00 a.m.	SURGICAL GRAND ROUNDS - "Interesting Cases of the Week." MHMH (Bowler) - CGH (Conference Room) - CVMC (Board Room)
	10:00-11:00 a.m.	MATERNAL AND NEWBORN CONFERENCE - Dr. John Caffey, Columbia and University of Pittsburgh: "Radiographic Features in Infants." MHMH (Bowler) - CGH (Conference Room)

MHMH - Mary Hitchcock Memorial Hospital
UVM - Medical Center of Vermont
CVMC - Central Vermont Medical Center
CGH - Claremont General Hospital

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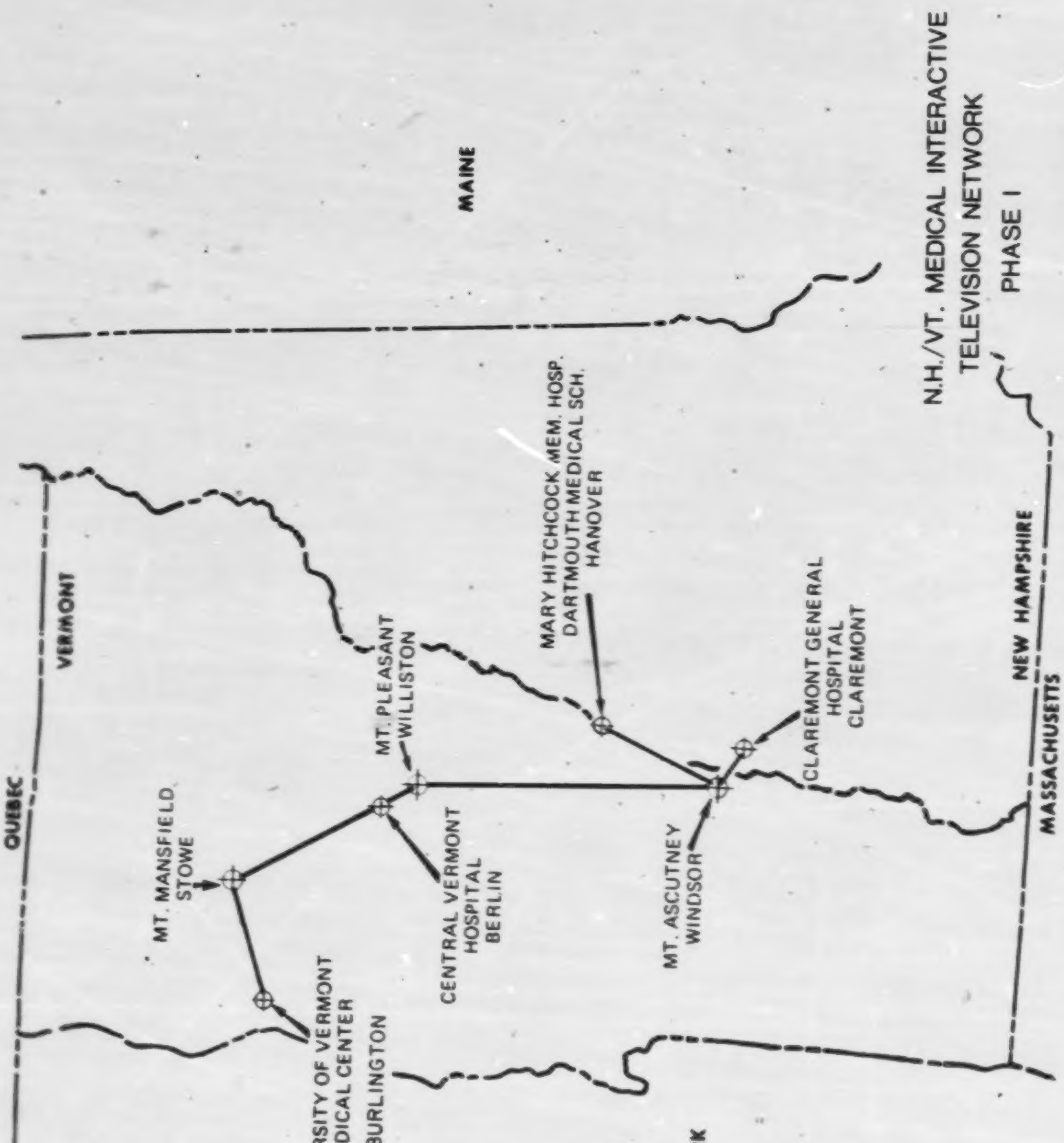
* CLOSED CONFERENCE - Open to involved professionals only.
** Open to any interested professional staff and allied health personnel.

DIAGRAM OF SYSTEM



N.H./VT. MEDICAL INTERACTIVE
TELEVISION NETWORK
PHASE I

QUEBEC
VERMONT
MAINE
NEW YORK
NEW HAMPSHIRE
MASSACHUSETTS
UNIVERSITY OF VERMONT MEDICAL CENTER BURLINGTON
MT. MANSFIELD STOWE
CENTRAL VERMONT HOSPITAL BERLIN
MT. PLEASANT WILLISTON
MARY HITCHCOCK MEM. HOSP. DARTMOUTH MEDICAL SCH. HANOVER
MT. ASCUTNEY WINDSOR
CLAREMONT GENERAL HOSPITAL CLAREMONT

12. TITLE OF PROJECT: Rural Health Associates: Interactive Medical Microwave Television

NAMES OF INSTITUTIONS AND TOWNS:

Rural Health Associates at
Farmington, Maine
Kingfield, Maine
Rangeley, Maine
Jay-Livermore Falls, Maine
(Last one not currently served by television)

PRINCIPAL PEOPLE, AND TITLES:

David C. Dixon, M.D., Medical Director
Clinton A. Conant, Executive Director

PROJECT BEGAN OPERATIONS: July, 1973

Equipment, Installation, and one-year's maintenance:

$240,000 (Estimated maintenance $5,000-$7,500 per year)

Funding Source: Office of Economic Opportunity (OEO)

PATIENT POPULATION SERVED AND SIZE [1]

P-A Approximately 14,000 patients on record as of December, 1973 (Catchment areas Farmington, 17,000, Rangeley, 2,000; Kingfield, 2,000; Jay-Livermore, 9,000.)

DESCRIPTION OF SYSTEM
TRANSMISSION MODES: A, E, F [2]

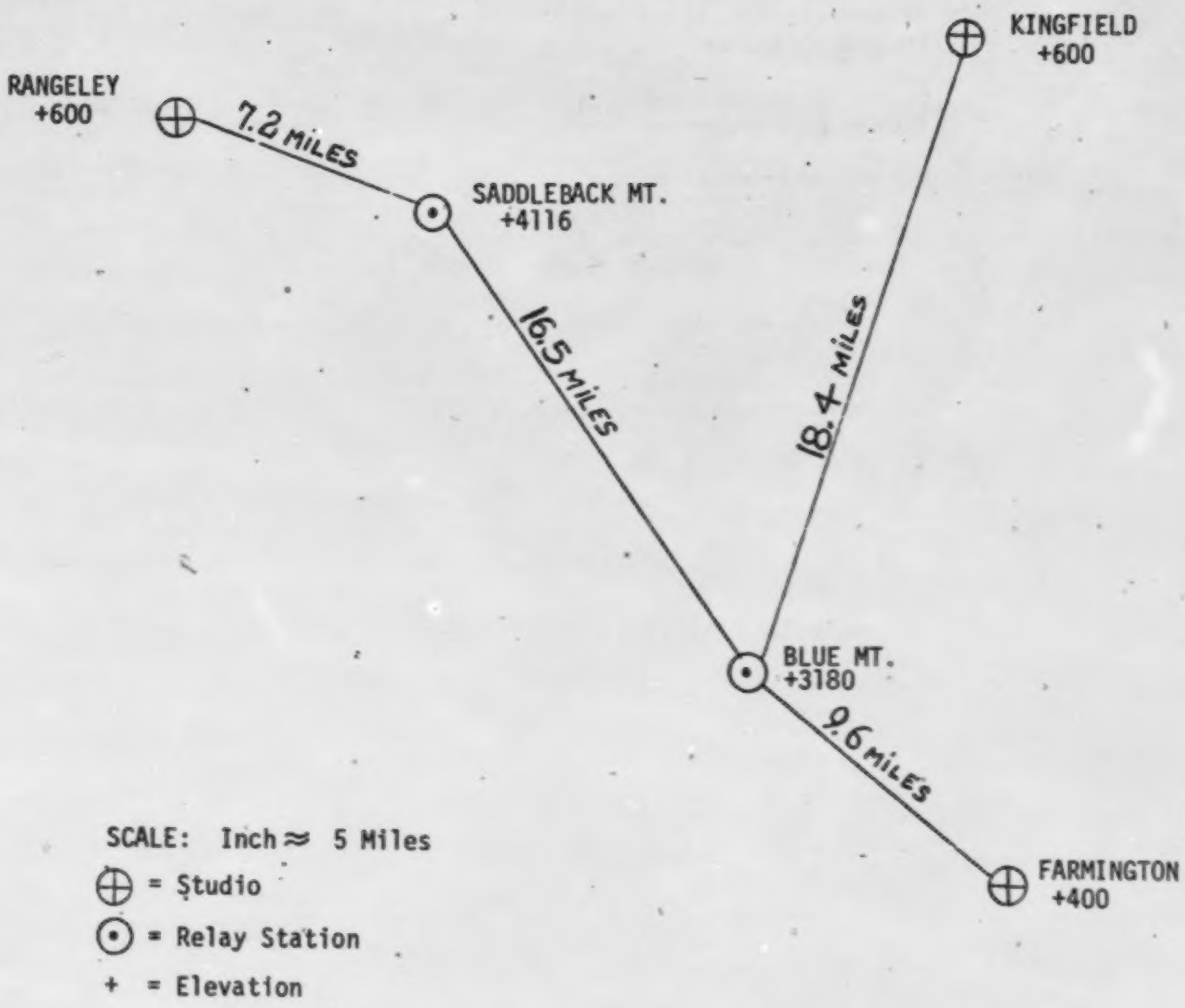
SYSTEM OPERATION, TYPE: S A [3]

FIELDS	SERVICES	INTERACTIVE MODE
General Medicine	Consultation	P? MD-PNA, FNA * or Medex
Specialist Medicine	Consultation	P? MD-MD or MD-PNA, FNA, Medex
Medical Conferences	Conference	Staff-Staff
Administration	Conference	Staff-Staff
Patient Education	Teaching	Health Educator-Patients (Salt-free diets; diabetic regimens)
Medical Grand Rounds	Conference	MD-MD (and other staff)
Continuing Education	In-Service Training	(Being planned, as of December,1973)

*PNA Pediatric Nurse Associate *FNA Family Nurse Associate

HOURS SYSTEM IS IN USE, PER MONTH: Data not available
NUMBER OF TRANSACTIONS, PER MONTH: Data not available
TYPICAL SCHEDULE: Data not available

DIAGRAM OF SYSTEM (Stations and Relay Stations)


KINGFIELD
+600
RANGELEY
+600
7.2 MILES
SADDLEBACK MT.
+4116
16.5 MILES
18.4 MILES
BLUE MT.
+3180
9.6 MILES
FARMINGTON
+400
SCALE: Inch ≈ 5 Miles
⊕ = Studio
⊙ = Relay Station
+ = Elevation

13. TITLE OF PROJECT: University of Nebraska Medical Center Slow Scan Radiology Project

NAMES OF INSTITUTIONS AND TOWNS:

University of Nebraska Medical Center
42nd and Dewey
Omaha, Nebraska

Jennie M. Melham Memorial Medical Center
Broken Bow, Nebraska

PRINCIPAL PEOPLE AND TITLES:

William J. Wilson, M.D., Chairman, Department of Radiology University of Nebraska Medical Center, Project Director.

Ted A. Koefoot, M.D., Coordinator, Rural Health Education Program, Broken Bow, Nebraska

Kristan Roskoski, Project Analysis Coordinator.

PROJECT BEGAN OPERATIONS:

November 11, 1973

BUDGET:

1st year budget: $128,654

Funding Source: HCTD

PERIOD:

Period of grant: 6/30/73 - 6/29/75

PATIENT POPULATION SERVED AND SIZE [1]

P-A General population in area of Broken Bow

P-B Melham is 85-bed community hospital

DESCRIPTION OF SYSTEM TRANSMISSION MODES:

F, H. [2]

SYSTEM OPERATION, TYPE: S A [3]

FIELD	SERVICE	INTERACTIVE MODE
Radiology	Consultation	MD-MD

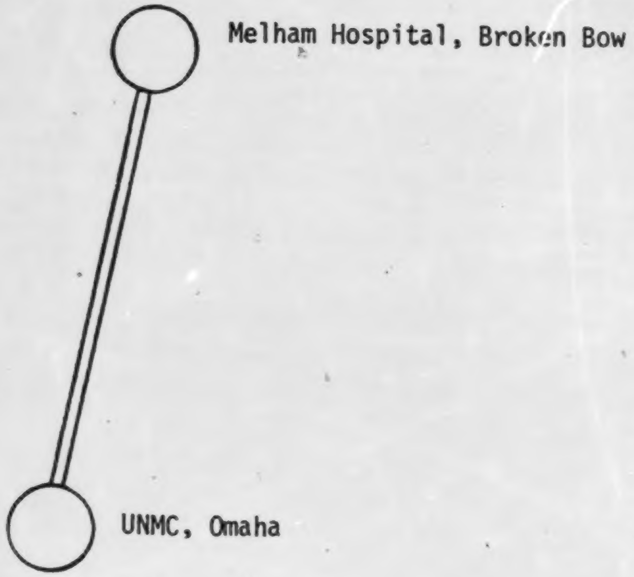
HOURS SYSTEM IS IN USE, PER MONTH: Not available

NUMBER OF TRANSACTIONS, PER MONTH: Not available

TYPICAL SCHEDULE:

Transmissions are made when primary care physicians at Broken Bow request consultation and on a regular basis to test the system.

DIAGRAM OF SYSTEM:



NOTE: Slow-scan video (Westinghouse Slo-Scan) operates one-way on ordinary voice-grade telephone lines.

Audio two-way (telephone)

APPENDIX B

TELEMEDICINE TIME-SHARING ON CABLE TV

ANALOGUE

In wideband cable television systems there are up to 40 forward transmission channels and 8 return channels. In spite of this large spectrum, as programming becomes more available to CATV, these channels will soon become saturated. Since the density of information contained in 1/30 of a second represents an entire television "frame," an X-ray, dermatological lesions, photographs, fluoroscopic stills, case histories, patients' records, prescriptions, etc., could be transmitted via cable, extremely efficiently, on a time-sharing basis.

In order to send a number of different "frames" of information, a system of frame detection and storage is required. This would allow (with a single 4.5 MHz video channel) distribution of 108,000 different "pages" of video information per hour. Television receivers would be equipped with a device to capture and store this frame for extended periods of time. This storage mechanism may be magnetic, optical, electrostatic or electronic. Operationally, the devices would function as follows:

A physician is examining a patient at his clinic. The patient informs the doctor that there has been a history of heart trouble in his family. The physician or nurse requests from the hospital by use of a keyboard, copies of the patient's medical records, including previous X-rays, ECG's, etc.

This request is a "binary-encoded word" containing an address and the request. This word is sent from the clinic, through the cable, and received at the hospital for processing. The processing is done by a computer which controls delivery of information which is stored on magnetic discs. Once the information is located by the computer, it is prepared in consecutive pages for transmission to the doctor. Simultaneous with the first frame transmission is a command initiated by the computer to inform the doctor's send/receive terminal to receive this burst of information and capture it in a storage device. The time required for this transmission of video information is 1/30 of a second, allowing 30 different requests from various locations to be serviced in a single second. (Information transmitted to the doctor is in analogue form.)

Once the frame is received and stores at the physician's clinic, the image is displayed on his/her television set until he/she initiates another request to the computer to advance to the next frame, whereby the storage device dumps the original page or frame and replaces it with page 2.

It is important to note this form of information distribution is secure. When a request is made to the computer for information, the computer must recognize the identity of the sender in order to react to the request. The speed at which the picture is flashed is too great for the eye to detect, and therefore, no intelligence can be extracted without the proper identity/address being received. The storage device is triggered by the computer's return digital word, which contains the address of "where" the message is to go, so only the party requesting this information can capture it.

IMPLEMENTATION OF REAL-TIME WITH SHARE-TIME

While "pages"* of video information are being flashed to the clinic, rural doctor or patient's home, it is possible to have a real-time television contact taking place. This is because the frequency of requests made by the universe of doctors served on the cable system is but a fraction of the number of frames transmitted per minute. Therefore, it is possible to insert during the real-time communication, a frame in every 30 to be transported to a discrete/secure address, be captured and stored for study. The interruption is so sudden that the viewer watching his/her TV set would not be able to detect any change in program format.

REAL-TIME SOUND TRANSMISSION VIA CABLE

Along with the picture information being transmitted via the cable, within the same 6 MHz channel can be added at least one additional channel for audio. The technique employed would be identical to the current system used in subcarrier transmission by FM stations. A subcarrier adaptor would be an addition to the doctor's terminal to allow narrative comment on "frame-displays" without interruption of normal program viewing and listening.

PRACTICAL CONSIDERATIONS OF TIME-SHARING

1. Practical use of time sharing of a TV channel via CATV would require further development of storage devices. At this time, the cost for an image storage tube is restrictive and its primary implementation is with the military.

2. A terminal with keyboard must be developed to achieve radio data reception/transmission and provide trigger signals for storage tube to record or dump the frame.

3. Lastly, a computer system must be designed to allow assembly of the stored information and presentation in video form for transmission.

All three requirements for this scheme of communications exist today, but in slightly different forms. With application of these technologies in volume, the system becomes cost-efficient and spectrally-efficient, and improves the physician's efficiency, as well.

Gary Schober
Consultant

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* Recall these may be X-rays, photographs, frames of videotape, etc., as well as records.

APPENDIX C

GLOSSARY

AMPLIFIER - a device consisting of electronic components through which signals are strengthened.

ANALOG SIGNAL - a continuously varying voltage which reflects variations in some quantity, such as loudness of the voice.

AUDIO - that frequency of the electronic spectrum which refers to sound detectable by the human ear, generally 20 Hz to 20,000 Hz.

AUTOMATIC GAIN CONTROL (AGC) - a circuit which automatically controls the gain of an amplifier so that the output signal level is virtually constant for varying input signal levels. Sometimes referred to as Automatic Level Control (ALC).

AUTO-SLOPE CONTROL - a CATV system control device that automatically corrects unwanted differences that may develop between the high and low frequency portions of the bandpass. Flat response is therefore assured.

BAND - a range of radio frequencies within two definite limits and used for a definite purpose; for example, the Standard Broadcast Band extends from 550 to 1600 kilohertz, VHF television from 54 to 216 megahertz; UHF television from 470 to 890 megahertz, and Domestic FM from 88 to 108 megahertz.

BANDWITH - the range of frequencies required to convey electronic signals such as: audio, video, telemetry, data, etc.; the range of frequencies that can be passed by a transmission medium or piece of electronic apparatus without undue distortion.

BASEBAND - that spectrum of frequency relating to the most basic form of electronic signals, before any modulating processes are initiated.

BIT - an abbreviation for binary digit. The term is used whenever information is presented in digital form by the binary number system.

BIT RATE - rate at which bits are transmitted. Maximum bit rate is a function of bandwidth.

BROADCAST - radio or television service on standard assigned frequencies available in the home on conventional receivers. Stations may be commercial or noncommercial. (Open circuit transmission).

CATV - An acronym for Community Antenna Television. Now used to designate cable television as in "local CATV system."

CCTV - closed circuit television, as opposed to broadcast television. CCTV signals are confined to cables, microwave links, lasers, or other transmission media which provide controlled access.

CABLE POWERING - a method of supplying power to solid-state CATV equipment by utilizing the coaxial cable to carry both signal and power simultaneously.

CAMERA CHAIN - TV camera plus the associated electronic equipment necessary to deliver a complete picture for telecasting.

CASCADED SYSTEM - the repeaters or amplifiers in a cable system are connected in sequence (cascade) with the output of one device feeding the input of the next.

CHANNEL - a range or "band" of frequencies assigned for the transmission of communications signals; in television it is the group of frequencies comprising the transmitted visual (video) and sound (audio) signals.

CHANNEL ALLOCATION - the channel or band in the radio spectrum to which a television station is assigned, or the channel space in the radio spectrum to which a communication service is assigned.

CLOSED CIRCUIT - a private wire or radio circuit used as one means of carrying or conveying from one location to another an audio or television program for specialized audience use (see CCTV).

COAXIAL CABLE (concentric line) - a transmission line formed by coaxial conductors, each insulated from the other by some suitable dielectric insulating material such as air,polyethylene, polyfoam, Teflon, etc.

CO-CHANNEL INTERFERENCE - Distortion resulting from two transmitted TV pictures on the same frequency or channel mixing together within the television receiver.

COMBINING NETWORK - a network which permits the addition of several signals into a combined output with a high degree of isolation between individual inputs. Sometimes called "mixer."

COMMUNICATIONS CHANNELS - cable or radio connections through which video, voice, data, telemetry or other information may be transmitted. Important parameters of a channel are bandwidth, noise figure, cross-modulation and fidelity.

COMMUNITY ANTENNA RELAY (CAR) - a class of microwave relay service to provide signals for Community Antenna Television.

COMMUNITY ANTENNA TELEVISION (CATV or Cable-TV) - a master antenna array and the signal distribution system, i.e., the amplifiers, antennas, coaxial cable connecting devices, etc., necessary to distribute several TV signals throughout a community (see CATV).

COMPATIBLE COLOR SYSTEM - a color television system that permits normal black and white reception of its transmitted signals without altering currently used receivers.

CONVERTER (Signal Processor) - a device to change the channel or frequency of a signal, used in CATV systems to shift transmission from one channel to another.

COMMON CARRIER - a communications service that must be made equally available to the general public.

CONDITIONED TELEPHONE LINE - a telephone channel that has been modified for a special communication use.

CONDUIT - a tube, manufactured of an environment protective material, through which coaxial cable is conveyed (underground, within structures, etc.).

CROSS-MODULATION - a form of distortion where modulation of an interferting station appears as a modulation of the desired station. Caused by third and higher order nonlinearities.

DATA CHANNEL - a communications channel for handling digital data (such as teletypewriter, digital computer), or analog data (such as "Electrowriter," facsimile, life sign telemetry or slow scan TV).

DECIBEL - a unit expressing a power or voltage ratio. Decibel (or dB) ^{dB}power = 10 log P_1/P_2; ^{dB}voltage = 20 log E_1/E_2.

DEMODULATION - the process of removing the video, audio and data signals from their respective carrier waves. Recovering the original signal form.

DROP - the small cable used to connect a subscriber's set to the cable system.

DUPLEX CIRCUIT - two-way communications circuit. Signals travel in both directions.

ECG (Electrocardiogram) -- a visualization of measurement of electrical activity associated with the heart, by paper tracing or cathode-ray tube display.

EEG (Electroencephalogram) - a visualization of measurement of electrical activity associated with the brain, usually on a paper tracing.

EIA (Electronic Industries Association) - EIA provides recognized standards for a wide variety of communications equipment and systems.

EMG (Electromyogram) - visualization of electrical activity associated with muscles.

EQUALIZATION - a means of modifying the frequency response of an amplifier or network, thereby resulting in a flat overall response.

FACSIMILE - any of several techniques for sending half tone, hard copy pictures by wire or radio circuits. Transmission speed is typically 2 to 5 minutes per picture. In a broad sense - slow scan television where the end picture is produced on paper instead of a picture tube.

FEDERAL COMMUNICATIONS COMMISSION (FCC) - the U.S. Government agency governing all civilian radio and TV radiations in the air and, to some extent, those through wire or cable.

FIDELITY - the degree to which a system, or a portion of a system, accurately reproduces at its output the essential characteristics of the signal that is impressed upon its input.

FRAME TENSION - a term coined by the author to describe the awareness of an observer that spatial phenomena within a television or motion picture frame are continuous with spatial phenomena immediately outside and extending for an indefinite distance beyond the frame.

FRANCHISE - the agreement between a CATV operator and the governing municipal authority in which the CATV operates.

FREQUENCY - number of cycles per second or Hertz.

FREQUENCY DIVISION MULTIPLEX (FDM) - separation of channels by use of carriers of diverse frequency.

GHOST - multiple reception of a transmitted signal at slightly different times.

GIGAHERTZ (GHz) - 1,000 MHz microwave frequencies.

HARD COPY - a printed copy of machine output in readable form, for example, reports, listings, documents, summaries, pictures.

HEAD-END - In the Cable-TV industry: the location of facility used in receiving and processing television and radio signals for subsequent transmission throughout a CATV system.

HERTZ (Hz) - 1 cycle per second.

INTERACTIVE - terminals or circuits providing two-way communication.

INTERFERENCE - disturbance in radio reception caused by undesirable signals or stray currents from electrical apparatus, atmospheric static, electrical noise, etc.

INTERMODULATION - a form of distortion where two modulated or unmodulated carriers are algebraically added or subtracted according to the frequency relationship $f = nf_1 \pm mf_2$, where n and m are whole numbers. Intermodulation is caused by second and higher order curvature.

ITSF - Institutional Television Fixed Service; a band of frequencies assigned for use by public institutions.

KILOHERTZ (KHz) - 1,000 cycles per second.

MEGAHERTZ (MHz) - 1,000,000 cycles per second.

MDS (Multipoint Distribution System) - an omni-directional microwave system operating at 2,150 MHz to 2,160 MHz under franchise by the FCC as a common carrier.

MICROWAVE - Radio waves above UHF frequencies, generally 2,000 to 15,000 MHz (2-15 GHz). Because of their short wavelength, they begin to behave as visible light.

MICROWAVE RELAYS - systems used for transmission of video and audio signals by highly directional radio beams at frequencies between 2,000 and 15,000 MHz. Distances of typically 30 miles may be covered by a single link consisting of a transmitter and receiver; longer distances may be covered by multiple links receiving and transmitting the original signal.

MODULATION - the process of impressing audio, data, or video information on the carrier wave for transmission via wire or radio.

MONITOR - to control the picture shading and other factors involved in the transmission of both a scene and the accompanying sound. Monitoring usually occurs at the studio control room and at the transmitter. Also denotes a special type of high-quality television receiver.

NETWORK - an interconnection or assembly of remote stations via cable, microwave, wire, or radio-frequency transmission.

NOISE FIGURE - a measure of the noisiness of an amplifier. Noise factor is defined as an input signal-to-noise ratio to output signal-to-noise ratio. Noise figure is noise factor expressed in dB. The lowest possible value for a matched system is 3 dB.

OFF-THE-AIR - reception of a TV signal that has been broadcast over free-space transmission and received with an antenna.

OPEN CIRCUIT - general term applying to Broadcast Television on VHF and UHF channels. Implies the availability of reception to the public within range of the TV stations.

PLUMBICON - a type of television camera pick-up tube, also known as the lead-oxide vidicon. This type is most commonly used in more expensive professional television cameras, especially in color units.

POLE ATTACHMENT - when wire systems use existing pole lines maintained by power and telephone companies, the coaxial cable must be attached to the poles and an attachment contract must be negotiated between the parties of interest.

PROXEMICS - term coined by E.T. Hall (The Hidden Dimension, Achor Books, Doubleday & Co., Inc., Garden City, N.Y., 1969), "For the interrelated observations and theories of man's use of space as a specialized elaboration of culture." Hall's thesis, based on principles laid down by B.L. Whorf and other linguists, is that culture is a major element in the formation of thought, that humans are programmed by their culture to register and structure external reality in ways specific to their culture.

R.F. - radio frequencies.

RELAY STATION - a station used to receive picture and sound signals from a preceding station and to transmit them to another relay station or to a television broadcast transmitter.

SCRAMBLER - device used to encode the transmission of information on a secure basis.

SECURE TRANSMISSION - private transmission and reception.

SIGNAL - information transposed into electrical impulses. Two basic signals are involved in television transmission - the picture or video signal and the sound or audio signal. Each signal contains electrical impulses representing the elements transmitted.

SIGNAL TO NOISE (S/N) RATIO - the ratio of desired to undesired electronic information, usually expressed in decibels (dB).

SLOPE - difference in amplifier gain, or change in cable attenuation, between the highest and lowest frequency channels carried on the cable system. Expressed in dB.

SPECTRUM - a large range of electromagnetic radiations.

SYSTEM NOISE - that combination of undesired and fluctuating disturbances within a cable television channel that degrades the transmission of the desired signal and that is due to modulation processes or thermal or other noise-producing effects, but does not include hum and other undesired signals of discrete frequency.

TARIFF - a schedule of services and rates filed by common carriers with regulatory bodies.

TELEMETRY - remote metering, via a communications channel, of analog data such as ECGs or EEGs.

TELEVISION CHANNEL - a band of frequencies 6 megacycles wide in which are contained all of the frequency components of a television broadcast signal (picture and sound).

TERMINAL -
1. a point at which information can enter or leave a communication network,
2. an input/output device designed to receive or send source data in an environment associated with the job to be performed and capable of transmitting entries to and obtaining output from the system of which it is a part.

TILT - difference in level or amplitude between the highest frequency channel and the lowest frequency channel carried on the cable system.

TRANSACTION - a health information exchange in real time using confidential circuitry with the informed consent of all parties involved. A purposive interactive encounter between or among individuals, groups, or individuals and groups. In this report, it is used to connote encounters in the interactive television medium for the purpose of information exchange in patient care, health education, or administration.

TRANSMITTER - the electronic device for generating a radio frequency signal.

TRUNK - the major cable link from the head-end to a community or connecting communities.

UHF - Ultra High Frequency, normally between 300 MHz and 3,000 MHz. In television, Channels 14 through 83.

VELOCITY OF PROPAGATION - speed of signal transmission. In free space, electromagnetic waves travel with the speed of light. In coaxial cables, this speed is reduced. Commonly expressed as percentage of the speed in free space.

VHF - Very High Frequency, normally between 30 to 300 MHz. In television, channels 2 through 13.

VIDEO - of or concerning sight. Specifically, those electrical currents representing the elements of a television picture.

VIDEO SIGNAL - the frequencies generated by the scanning of a scene or image plus the synchronizing pulses involved.

VIDEO TAPE - a magnetic tape for recording television signals.

VIDEO TAPE RECORDER (VTR) - proprietary name of the Ampex Corporation for a television tape recorder. Currently a generic term.

VIDEO TELEPHONE - an instrument designed to deliver both visual and auditory information using a transmission system permitting switched or random access among users. Currently, the only video telephone which has been widely deployed (approximately 500 instruments in use, the bulk of them in Chicago and environs) is the Picturephone(R) developed by A.T. & T. Other video telephones have been developed by General Telephone and Electronics Laboratories, Inc. (Pictel) and Stromberg-Carlson Corp. (Vistaphone R).

VIDICON - A type of television camera pick-up tube, relatively inexpensive and small in size but having light sensitivity limitations.

VOICE GRADE CHANNEL (Voice Circuit) - a channel suitable for transmission of speech, digital or analog data, or facsimile, generally with a frequency range of about 300 to 3,000 cycles per second.

ZOOM LENS - a lens providing a range of fields of view (for example 12 mm to 120 mm—a "10:1 zoom") in an uninterrupted continuum. The zoom lens may be used to go, in focus, between wide angle and closeup or any intermediate view.

ERRATA: (does not include minor typographical errors)

"An Introduction to Telemedicine"

p. ii Insert between paragraphs 5 and 6:

Rashid Bashshur has given me invaluable criticism and suggestions both as an experienced student of medical care and as a friend.

p. 4 Add at end of last line:

to hostile where they feel challenged.

p. 10 Add at end of last line:

so admirably begun.

p. 41 Change in heading, upper left:

The word "Human" for "National".

p. 46 Fifth paragraph, first line:

... images are devised ... (not or)

p. 46 Change in last line, first word:

talker (not walker)